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FARADAY'S DIARY

VOL. I



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MICHAEL FARADAY

FARADAY'S DIARY

Being the Various Philosophical Notes
of Experimental Investigation

made by

MICHAEL FARADAY

D.C.L., F.R.S.

during the years 1820-1862

and bequeathed by him to the

ROYAL INSTITUTION OF GREAT BRITAIN

Now, by order of the Managers,

printed and published for the first time,

under the editorial supervision of

THOMAS MARTIN, M.Sc.

with a Foreword by

SIR WILLIAM H. BRAGG, O.M., K.B.E., F.R.S.

Director of the Laboratory of the

Royal Institution

VOL. I

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FOREWORD

THE MANAGERS OF THE ROYAL INSTITUTION OF GREATBRITAIN have had in their care for many years the manuscript records of the researches of Michael Faraday. They cover the years from 1820 to 1862, during which period he worked in the laboratories of the Institution. He was in the habit of describing each experiment, in full and careful detail, on the day on which it was made. Many of the entries discuss the consequences which he would draw from what he had observed. In other cases they outline the proposed course of a research about to be undertaken. Thus the Diary is far more than a catalogue of results. The reader is able to follow the advance, step by step, to final and fundamental conclusions. He sees the idea forming, its experimental realisation, and its employment as a foothold for the next advance.

The results of Faraday's researches were described by him in papers contributed, for the most part, to the Royal Society. They were collected by him in his well-known *Experimental Researches*. The demonstrations and arguments of the Diary have therefore been given to the world already. The main interest of the Diary lies, however, quite outside the range of propositions and experimental proofs. It centres round the methods of Faraday's attack, both in thought and in experiment: it depends on the records of the workings of his mind as he mastered each research in turn, and on his attitude not only to his own researches but also to scientific advance in general.

Faraday is generally held to be one of the greatest of all experimental philosophers. Nearly every science is in his debt: and some sciences owe their existence mainly to his work. The liquefaction of gases, benzene, electromagnetic induction, specific inductive capacity, lines of force, "magnetic conduction" or permeability, the dark discharge, anode, cathode, magneto-optics, electrochemical equivalent; all these terms suggest funda-

mental researches which he made, and many of them were called into existence in order to describe his discoveries. It is extraordinary that a man who did such excellent work, should also have excelled in his description of it.

Moreover, the industrial applications of Faraday's discoveries are enormous in their magnitude and variety.

The Managers believe therefore that the publication of this Diary will be widely welcomed, by all who are interested in the growth of a knowledge which has had so large an influence upon the shaping of the modern world, both in thought and in practice, and by those who would know more of the man who wrote it.

The portion of the Diary reproduced in this present volume describes Faraday's work from Sept. 1820 to June 1832. The reproduction of the whole Diary will require six volumes more. The volume contains several descriptions of great interest. In March 1823 he records his experiments on the liquefaction of gases. In 1825 he isolated and examined "bicarburet of hydrogen", now known as benzene: the entries from April to June give a full account of his determination of its chemical composition and reactions. A number of other chemical investigations of various kinds occupied most of his time until 1831. On August 29 of that year he began the long series of researches on electromagnetism which formed the principal work of his life. The first day's experiments showed him the true character of a long sought for effect: it was to be the reciprocal of that which had been demonstrated by Oersted eleven years before and had afterwards been extended by Ampère. An electric current could produce magnetism. Faraday discovered on that day how magnetism could be made to produce an electric current. The work of the next few months cleared the position rapidly: and an entry of March 26 in the following year shows that Faraday had grasped "the mutual relation between electricity, magnetism, and motion".

W. H. B.

PREFACE TO VOLUME I

THE manuscript which is now generally known as Faraday's "Diary" has been in the possession of the Royal Institution since its author's death in 1867. The Minutes of the Managers for November 4th, 1867, record the bequest to the Institution by Professor Faraday of his "Experimental Notes", and a marginal entry in the Minute Book, which is evidently a quotation from the actual bequest, giving the date January 16th, 1855, describes the MSS. as consisting of "Various philosophical notes of experimental investigation on foolscap paper, paged in series, and partly bound in five volumes, a quarto MS. book of Philosophical Notes, a second larger quarto of similar notes. . .". Before his death Faraday had evidently had a sixth volume bound, for the minute refers to six folio volumes as well as to some unbound foolscap MS. The loose papers were subsequently bound up, by order of the Managers, making folio volumes 7 and 8.

These two quarto and eight folio volumes, containing upwards of four thousand closely written pages, constitute the Diary as it is to-day. In the commonly accepted sense it is not a diary at all, but a laboratory note book, a day to day record of experiments and observations of a scientific character. At first this record was kept in bound books, the two quartos; but afterwards sheets of plain foolscap paper were used, to be bound later into volumes. The pages are numbered and dated throughout, with the date as a rule methodically repeated at the top of each page. The separate paragraphs are also numbered, except in the early bound books, in which, instead of the numbering, marginal headings have generally been written in vertically at the sides of the pages, for ease of reference.

Overlapping and irregularities in the order of date will be found, particularly in the two quartos, in which it is clear that

different parts of the books were in use at the same time, and Faraday turned back to complete entries or to describe further experiments after intervals of weeks or months or sometimes years.

The second quarto is only two-thirds filled, and it is evident that about 1831 he found the plan of keeping his notes on loose sheets much more to his liking. This method was adopted for the work recorded in the first folio volume. In this volume too the numbering of the paragraphs is started, and there are several short sequences up to June 1832. Then in Folio Volume II, on August 25th, 1832, a new series of numbers is begun, and runs in an unbroken sequence of over sixteen thousand paragraphs nearly to the end of the Diary. The dates and paragraph numbers of the original are as follows:

Quarto Vol. I.	Sept. 1820 to Dec. 17, 1823.	
Quarto Vol. II.	Dec. 10, 1823 to Oct. 1, 1833.	
Folio Vol. I.	(i) Feb. 1828.	
	(ii) Feb. 2, 1831 to Mar. 14, 1831.	Pars. 1-72.
	(iii) June 17, 1831 to July 18, 1831.	„ 1-147.
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Folio Vol. II.	Aug. 25, 1832 to Jan. 15, 1836.	Pars. 1-2817.
Folio Vol. III.	Jan. 15, 1836 to Nov. 5, 1838.	„ 2818-5060.
Folio Vol. IV.	Nov. 5, 1838 to Jan. 10, 1845.	„ 5061-7299.
Folio Vol. V.	Jan. 10, 1845 to Jan. 21, 1850.	„ 7300-10740.
Folio Vol. VI.	Jan. 21, 1850 to Dec. 19, 1854.	„ 10741-13591.
Folio Vol. VII.	Mar. 3, 1855 to Mar. 6, 1860.	„ 13592-16041.
Folio Vol. VIII.	Nov. 25, 1861 to Mar. 12, 1862, and Miscellaneous.	

Many of the pages have a pencil line drawn vertically down the centre. It seems to have been Faraday's practice to cross through in this way passages made use of in the preparation of papers for publication.

The Diary is illustrated with freehand sketches, placed usually towards the right-hand margin of the page, and evidently drawn with the fine pen used for writing. Only very occasionally is a formal drawing produced with the help of ruler and compasses. So

numerous are the illustrations in some parts, and so characteristic a feature of the manuscript are they, that the problem of their reproduction in the printed book has called for special consideration. It may be of interest to say that the method of taking photostat prints of all those pages of the Diary containing illustrations has been found the most convenient. The process is much simpler and quicker, and involves less risk of injury to the original, than the alternatives of tracing or redrawing, or of setting up the manuscript and photographing each illustration separately in the usual way. The blockmaker works with equal facility from the paper negative obtained by the photostat process, and the spirit of the original drawing is preserved in the resulting facsimile impressions.

The placing of the diagrams in the margin is no new device in book illustration. It was used in some of the early editions of Euclid, and a particularly fine example of the method, which was consulted at the British Museum, by the courtesy of the Keeper of the Printed Books, when the treatment of the drawings in the Diary was under discussion, is the "*Cursus quattuor mathematicarum artium liberalium*" of Petrus Ciruelus Darocensis, published in 1516. But if the marginal arrangement of illustrations is not new, it is sufficiently unusual to call for some explanation, particularly as it may be thought to have some relation to the disposition of the diagrams in the original manuscript. And so indeed it has.

In the written pages the diagrams are invariably adjacent to the matter they illustrate; and it was deemed important to preserve this contiguity in the printed text, for ease of reference, and because any alteration of the relative positions of diagrams to text would have led to the introduction of figure numbers which are not in the original, a step which would have altered to some extent the free character of the Diary. But with the reduced scale of the printed as compared with the written page, correct placing would often have been difficult, and on crowded pages impossible, if the

general practice of inseting the diagrams in the type area had been followed. The difficulty will be apparent on reference to some of the heavily illustrated pages.

With the diagrams removed to the margin, each one is placed opposite the paragraph it illustrates; except when its shape or size, or the proximity of others, makes it necessary to place it at the foot of the page, in which case a reference mark and number in square brackets denote the paragraph to which it belongs. This arrangement of the illustrations has the added advantage that it gives an unbroken text for reading; while the facsimile sketches, with their freehand lines, gain by being less closely contrasted with surrounding type.

The majority of the illustrations in this volume have been reduced in size to three-quarters of their original linear dimensions. It has seldom been necessary to use a greater scale of reduction, for in the manuscript the diagrams are generally small. In some cases they have been reproduced full size.

The text has presented a number of those problems which must always attend the reproduction in type of a manuscript not designed by its author for publication. The handwriting in the original is generally clear and legible, and with experience in reading it acquired during the progress of the work, doubtful passages have usually been resolved on returning to them, but a few isolated words or short sentences have proved undecipherable. For these it has been thought better to print the word "illegible", enclosed in square brackets, rather than to guess at the meaning. Very few variations from the original text have been allowed. Here and there, however, a missing word or part of a word has been inserted, where it assists to make the meaning clear. All such additions are enclosed in square brackets. The pages of the printed book cannot, of course, correspond with those of the manuscript, so that some variation from what is actually written has been necessary in the matter of repetition of dates, and of marginal headings where these are used; but in this Faraday's own general

practice has been followed, of repeating the last new date or marginal entry at the head of the next page.

It is hardly necessary to say that peculiarities of spelling have been everywhere retained; even when, as sometimes happens, a word is differently spelt at two places on the same page. Redundancies, as when a word has been inadvertently repeated, or where there is a clear intention to alter a sentence and a word or words have not been struck out, have generally been omitted. Blanks, that is, spaces in the text for numerical or other entries which have never been filled in, have been left as blanks.

Perhaps the most difficult problem has been that of punctuation. In the Diary, Faraday frequently disregarded grammatical construction, and he even more frequently wrote without, or almost without, punctuation. Occasionally the customary punctuation marks were used, with capitals following the full points. In other places the only sign is a short horizontal stroke or dash. Elsewhere long passages occur without break or indication of any kind, except such as can be got occasionally from the spacing of the words.

The dashes have been preserved in places where they occur; and punctuation has been inserted throughout the book, but sparingly, and with the objects of removing ambiguity and assisting the reader rather than with a pedantic insistence on the inclusion of every comma. Not infrequently, and particularly in ungrammatical sentences, the meaning is determined by the punctuation. If in such sentences the meaning has remained in doubt after full consideration, punctuation has not been added.

Another problem has been that of the abbreviations, which in some parts are much used. Faraday sometimes slurred the ends of his words in writing in such a way as to leave it in doubt if an abbreviation was intended or if the word was only hurriedly written. It has been difficult to establish a consistent practice in dealing with such cases, but as far as possible only words in which it has been judged that a definite shortening was intended have

been printed as abbreviations. All such words are followed by a full point in the text. Of abbreviations regularly used, the majority are self-explanatory, but the short list given on page xxv may be of assistance.

A special case is that of the word "and". Although Faraday sometimes wrote this in full, he more frequently used a looped sign for it, rather like the Greek α , which would have been very imperfectly represented by the printer's ampersand. Moreover, the frequent occurrence of this sign in the text would have been typographically objectionable; and the word "and" has therefore been printed in full wherever it appears. A sign which is hardly distinguishable from that for "and" was used for "et cetera". This has been printed in the usual abbreviated form of "etc."

The conventional signs (* † ‡ § || ¶) have been used only for references to diagrams placed at the foot of the page. For references from one part of the manuscript to another Faraday sometimes used marks of his own devising, and to represent them certain special signs have been used which may readily be distinguished from those used for the diagrams. References to editorial footnotes are by numerals.

Lastly it may be said that the object in preparing this volume for the press has been to present in type as accurate a representation of the original as its form allows, and to preserve in the printed page at least some of the characteristics of the manuscript. Editorial comment has been indulged in as little as possible, and has been confined strictly to what is necessary for the elucidation of the text.

T. M.

ROYAL INSTITUTION

June 1932

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Cross references to Faraday's published papers have been given in the table of Contents, so that readers may compare the entries in the Diary, made during the progress of the experimental work, with the accounts of the same work which were subsequently written and published. The papers originally appeared in the *Philosophical Transactions of the Royal Society*, the *Quarterly Journal of Science*, the *Philosophical Magazine* and other journals, but they were afterwards collected by Faraday and printed in book form, in the *Experimental Researches in Electricity*, Vol. I (R. and J. E. Taylor) 1839, Vol. II (R. and J. E. Taylor) 1844, Vol. III (Taylor and Francis) 1855; and the *Experimental Researches in Chemistry and Physics* (Taylor and Francis) 1859. They are most conveniently consulted in these volumes, to which the page references have therefore been given, instead of to the original papers.

The inclusion of these cross references affords an indication of the extent to which the Diary was drawn upon by its author in preparing his published works, and enables the Contents to be used as a guide to all those other experiments and miscellaneous observations which were recorded from day to day, but which led to no results considered worthy of publication at the time, and of which no account has previously been printed.

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PLATES

Michael Faraday	<i>Frontispiece</i>
The entry recording the first successful experiment in electro-magnetic induction. <i>August 29, 1831</i>	<i>facing page 367</i>

Some abbreviations used by Faraday

bar. or B., baryta or barytic; also barometer.

C. A., carbonic acid.

c:i:, cubic inches.

cor. sub., corrosive sublimate.

M. A., muriatic acid.

mur. or M., muriate or muriatic.

N. A., nitric acid.

N. M., nitro-muriatic.

nit. or N., nitrate or nitric.

oleft., olefiant.

S. A., sulphuric acid.

sul., sulphate or sulphuric.

sul. cy., sulphocyanate or sulphocyanic.

sul. hy., sulphuretted hydrogen.

suls., sulphurous.

sulet. or sulrt., sulphuret.

QUARTO VOLUME I
OF MANUSCRIPT

ARTIFICIAL CAMPHOR. Rather heavier than water when fused—requires a higher heat than 212° for its volatilisation—readily fuses and is not so volatile as the new substance—burns with bright flame. It will bear fusion with potash for some minutes without decomposition. Heated with oxide of Zinc it is immediately decomposed giving mur. zinc and oil turpentine. Heated with Zinc it act on it evolving much Mur. Acid gas, probably also hydrogen and forming Mur. Zinc and oil of turpentine which remain fluid.

ARTIFICIAL
CAMPHOR.

Artificial camphor in chlorine—heated, partly sublimed and fused—much M. A. Gas formed, but bulk of gas not changed—hence chlorine absorbed, hydrogen evolved. Substance now seems purer than before, the first kind being probably a mixture of this with oil of turpentine. It was now not acid—volatile—crystallisable—not by any means so combustible as before, but when burning giving off very much smoke and M. A. Gas—soluble in Alcohol, etc. Acting violently on oxide of zinc making it of a very dark red or crimson colour and forming chloride of zinc—water—a little bituminous looking substance and a volatile combustible fluid matter exactly resembling in appearance and *smell* the volatile oil produced by distilling fixed oil 3 or 4 times.

Put a larger portion of the camphor into a retort and acted on it by chlorine, melting the substance in it. Nearly the whole of the gas became M. A. Gas—blew this out and put a second atmosphere in—whilst heating the substance in the retort it took fire within, the hydrogen burning and the charcoal depositing. It was only the vapour which burn[t], the portion below remaining unchanged except by a little dirt.

Put in fresh chlorine and it again burnt on heating—did so a third time—the fourth time it did not, the heat being very gently applied. The substance taken out—dissolved in alcohol—crystallised, etc. and examined proved still to be the same substance as before.

CHLORIDE OF
CARBON.

Chlorine and olefiant oil exposed in a retort to sun light soon act; the vessel becomes misty, the colour of the chlorine disappears, a little heat is extricated and the bulk of the gas perhaps from that cause appears increased. The gas contains much M. A. and there is a smell as of Phosgene gas. (Query oxygen present?)

Dendritical crystals gradually form; these may be washed in water, dissolved in Alcohol and crystallised.

The Substance is transparent—colourless—volatile and crystallising in flat dendritical crystals sometimes half an inch long—it [illegible] to the light—smell strongly aromatic and very like artificial camphor—soluble in cold alcohol and more soluble in hot—crystallises from hot solution in dendritical crystals or in prism (quadrangular?)—soluble in ether—precipitated from the Alcohol by water and then its smell very strongly developed. It is volatile in the air—a small thin crystal took about 2 hours to evaporate—has a slightly aromatic taste.

It is much heavier than water—alcoholic solution precipitated by water and left to stand, the substance gradually settles in a fine white powder. May be washed from acid in this way. Crystals of it instantly sink in water.

Put into a tube with water and heated, the substance did not fuse under the water or dissolve in it but it softened and then became vapour long before the water boiled. In this way it may be sublimed in water and well washed—the water brought off acid which had adhered to it. It was then dissolved in alcohol, a saturated hot solution being made; as it cooled beautiful dendritical crystals formed in the solution resembling those formed by sublimation.

A little of it heated in a glass tube with oxide of Zinc was partly decomposed and in part escaped—that which volatilised burnt when sent into the midst of the flame of a spirit lamp with a yellowish flame and smoke but ceased to burn the moment it was removed out of the flame, and the substance appeared in white fumes, easily condensable—the vapour apparently heavy—the oxide of Zinc in the tube blackened and when washed out by water a solution of muriate of Zinc was obtained. Query permanent gas liberated?

When Alcohol holding it in solution is burned acrid fumes are given out and M. A. Gas made evident by ammonia. CHLORIDE OF CARBON.

Query Its Spec. Gravity?

The quantity of it dissolved by hot Alcohol?

” ” ” cold alcohol?

” ” ” water?

The weight of its vapour?

The form of its crystals?

Under what pressure it fuses?

The Elasticity of its vapour?

1820. OCTR. 3RD.

Put Olef. oil into a retort—exhausted—introduced chlorine—exposed to light—after the action introduced a little water—this absorbed the M. A. Gas and made a fresh vacuum—let in more chlorine and again exposed to light, shaking the retort—fresh action, then more chlorine—when the substance all changed, filled up the retort with water so as to wash out the acid well—repeated washing—dissolved the substance in alcohol and crystallised. This saves exhausting by the air pump which is very injurious to the instrument.

OCTR. 4TH.

Made a similar expt. to the above in the large head, first filling with chlorine then letting in Olef. gas—forming the oil—afterwards giving more chlorine—exposing to light—putting in water, etc.—much of the substance formed.

Got a retort to exhaust, capacity 34.5 inches; put in 8.6 c: i: olef. gas, then 27 chlorine—exposed to light—oil formed and afterward the excess of chlorine acted on it to form substance—when colour gone, contraction of volume, and 8 c: i: more of chlorine entered, making 35 on the whole—exposed to weak sunshine—colour nearly gone—no further condensation—a good deal of crystals formed but much oil remaining unchanged—not chlorine enough in this experiment.

Some of the gas forced out over Mercury by heat: 12.5 gave 9.5 M. A. Gas absorbed by water and 3 of an unflammable gas; this was a mixture of Carbonic acid gas and nitrogen; 4.5 became

CHLORIDE OF 4 by potash hence the $12.5 = 9.5$ M. A. G., 2.667 Nitrogen and
CARBON. $.333$ carbonic acid.

Common air appears to have been with the chlorine and there was not enough of the latter. Try 5 vol. of chlorine to 1 of Oleft. gas.

Detonate vapour with oxygen.

„ „ „ hydrogen.

Send it over red hot oxide of copper or Zinc.

1820. OCTR. 5.

The crystals of the substance (from a strong alcoholic solution) were very brittle and crumbled into a white powder very easily. It is on this account difficult to preserve them. They were taken out of the Alcohol, dried by pressure between filtering paper, exposed to the air for half an hour and then put into a bottle. The substance was then a white dry powder.

The Alcoholic solution spontaneously evaporated; left crystals of the substance but they evaporated also in an hour or two afterwards.

The crystals by sublimation are much tougher than those formed from solutions.

The substance dissolves much more readily in Ether than in Alcohol. A hot solution of Ether deposits crystals as it cools. A glass rod dipped in it and exposed to the air is instantly covered with the substance in white powder from the evaporation of the ether.

Query acidity of solution? My ether was acid.

A drop of the ethereal solution put on a glass plate instantly expands, evaporates and its surface becomes covered with square crystalline plates, the crystals being dendritic and their axes lying parallel to the diagonals of the square. In this way the substance may be got very dry.

Water dissolves but a very small portion of it when boiled with it.

The solution of it in Alcohol is not acid—and is not precipitated by Nitrate of silver.

Solution of potash does not dissolve it perceptibly by boiling—nor Ammonia (strong). Muriatic acid does act on it.

Nitric acid (strong) boiled upon it dissolves a portion but does not decompose it: as it cools the substance deposits again unaltered. The concentrated acid diluted lets more of the substance fall; and then filtered and tested by N. of Silver gave no precipitate—hence no chlorine separated from the substance by it.

CHLORIDE OF
CARBON.

Put into strong Sul. Acid it very slowly sinks to the bottom, hence its S. G.; boiled with the acid the acid became brown, probably from some little pieces of dirt that were mixed with the substance. The substance sublimed from and through the acid unaltered and the acid tested contained no Mur. Acid or chlorine. It was not precipitated by water, hence no substance dissolved.

Clean dry retort: its capacity when tried by the air pump 34 c: i: but the air pump does not exhaust close. When measured with water its real capacity 35 c: i:.

This was first filled with nitrogen to exclude oxygen.

Then 3 inches of Olefiant gas let in and 31.5 inches of chlorine.

The chlorine examined and found to contain $\frac{1}{40}$ of common air.

Exposed at 2 o'clk. to sun light for 40'; at first the fluid formed and afterwards crystals—the excess of chlorine remained. At the end of that time it seemed perfectly dry and all action had ceased. It was now cooled to the Laboratory temperature.

Put it on to a jar of chlorine and opened the stop cocks—there was contraction of volume and 5.5 c: i: of chlorine entered, making 37 of that gas altogether.

A strong solution of chlorine was now made and admitted into the retort to absorb the M. A. G. It rose to a mark in the bulb of the retort which being afterwards measured equalled 13 inches absorbed, and the unabsorbed part being also measured = 22 c: i: —the absorption would have gone on still farther but from its slowness was evidently owing to the chlorine being taken up.

The 22 c: i: shaken in water were all absorbed except 1.75 which were azote; and the 20.25 were therefore chlorine—a very slight portion of C. A. was there.

The gases therefore in the retort were

20.25 c: i: chlorine

13 M. A. gas

1.75 Nitrogen

CHLORIDE OF
CARBON.

and the gases used were

36 chlorine because deduct nearly 1 for Nitrogen

3 Oleft. gas.

1.925 air in the retort left by the pump and with the chlorine.

As the common air and 20.25 of chlorine remain unchanged the active gases are

vols. $\left\{ \begin{array}{l} 3 \text{ oleft. gas} \\ 15.75 \text{ chlorine} \end{array} \right.$

and they form substance and 13 Vols. of M. A. G.

This vol. of M. A. gas is evidently too high because the olefant gas could not contain hydrogen for it, but the absorption by the solution of chlorine I have no doubt was carried too far. If that were 12 instead of 13 then the results would give the substance composed of 3 proportionals of Chlorine and 2 of carbon.

Try to-morrow with 5 vols. of chlorine to 1 vol. of Oleft.

Substance put into a syphon tube over Mercury and exposed to a heat of 220 did not volatilise, but the temperature within by no means so high; heated by a spirit lamp and the mercury made to boil in the vapour a chloride (calomel) gradually formed and the inside of the tube blackened in cooling; no elastic matter had been liberated.

Heat it this way with Iron over mercury: if no gas liberated its binary nature established.

1820. OCTR. 6TH.



A little of the substance put into a bent tube—sublimed to attach it; then two pieces of clean iron turning put in and the tube filled with mercury to exclude air—the substance converted into vapour and the iron heated in it nearly to dull redness—the Iron became dull and black as if with charcoal. When cold all the vapour had condensed, no permanent gas being liberated—the iron taken out and washed with distilled water gave a solution which, tested for Iron and Mur. Acid, was found to contain both.

Heated in the same manner with oxide of Zinc, Phosgene gas was evolved (Query any other gas) and chloride of Zinc sublimed; not the slightest trace of water.

Must repeat this experiment. *

CHLORIDE OF
CARBON.

Again had occasion to observe that mercury boiled in the vapour of the substance decomposed it, Calomel being formed and charcoal deposited.

Cleaned out the same tube as below * [above] with alcohol and repeated the experiment; got a certain bulk of gases of which rather more than 2 thirds were absorbed by water; the rest, being a small 1 third, burnt exactly like Carbonic oxide.

Repeat the expent. in a new tube and decant the gas before absorbing it by water so as to be able to test it for Carbonic acid and M. A. after the action of water. $\ominus$

Try red oxide of Mercury.

$\ominus$ Repeated the experiment in a new tube with oxide of Zinc and got as near as could be equal volumes of Phosgene gas and Carbonic oxide, i.e. equal volumes of a gas absorbed and unabsorbed: the latter ascertained to be Carbonic oxide.

Used the same retort as yesterday the capacity of which is 35 c: i:, filled it with Nitrogen—exhausted by air pump which took out 34 c: i:, then let in 5 inches of chlorine first by mistake; and afterwards intending to let in 5 c: i: of olefiant gas I think I put in only *four*. Then let in 26 more of chlorine, the quantity being thus great because condensation had began. It was then placed for a few minutes in the sun, when the fluid formed etc., and being cooled was placed on the chlorine when 7 c: i: entered. It was then exposed to the light for nearly an hour—cooled—and put over nitrogen, $\frac{1}{4}$ of an inch entered. There had entered therefore 38 chlorine, but this was found by previous examination to contain $\frac{1}{26}$ common air or unabsorbable gas. So that really there was in the retort 36.54 Chlorine

5 or 4 Olef. gas

$1\frac{1}{4}$ Nitrogen

1.46 Air.

The whole bulk of gas was 43.25 and the diminution 8.25, which halved will accord very nearly with 4 c: i: of olefiant.

After this the M. A. G. was absorbed by solution of chlorine and was between 15 and 15.5; the unabsorbed gas was from 20 to 19.5, and of this about 17 were chlorine and 2.5 were left by water and were Nitrogen.

CHLORIDE OF
CARBON.

Here the 15.5 is nearly the quadruple of the olef. gas used—agreeable to theory.

There was no expansion after the condensation of the elements of the oil; and here also the quantity of chlorine combd. with the carbon of 4 c: 1: olef. is 11.54, i.e. nearly 12.

Red oxide of Mercury was heated in the vapour of the substance as before in the tube. Calomel was formed and oxygen and carbonic acid gases evolved. The decomposition was by no means ready or complete though the heat was a dull red.

Repeated the experiment in another tube—the formation of a sublimate (calomel) as before by heating the vapour had been formed in the tube and then in part condensed below. When the lamp had expelled part of the oxygen from the oxide so as to form a very hot atmosphere of it within, then on applying the lamp below so as to raise more vapour of the substance explosion took place; a faint light appeared, and permanent gas remained which when examined was oxygen, Carbonic acid and (query) chlorine.

Repeated the experiment. Inflammation again and much brighter—carbonic acid tested for and found. Smell of chlorine very faint if at all—probably taken by the mercury whilst cooling.

Heated brown oxide of lead in the vapour—obtained oxygen—carbonic acid—the yellow sub chloride and the chloride of lead and yellow oxide.

To try the prot. oxide of Lead.

Heated per oxide of copper in the vapour—formed carbonic acid and chloride of copper.

1820. OCTR. 7TH.

CHLORIDE OF
CARBON AND
IODINE.

Made many experiments on the action of Iodine on the substance. Had small tubes and put in a little of each; then by heating the bottom of the tube by a spirit lamp and keeping that part hot so that the vapours which fell on to it should be highly heated, the following effects took place. At first the substances sublimed a little way, leaving below a small portion of a fusible matter which by the continuance of the heat effervesced and left solid films of charcoal (as ascertained by burning it afterwards). Then as the heat continued below, the vapours as they fell on to

it lost the colour of Iodine, became yellow, and the sublimed substances were of a deep brown colour. This volatile brown substance when left to cool remained fluid at common temperatures. Water added to it immediately separated iodine and a solution was obtained containing Muriatic acid? and iodine; this solution boiled so as to drive off the iodine then was acid and precipitated Nitrate of silver. The precipitate washed, dried and heated on platinum foil effervesced strongly and gave a blue flame, then fused into iodide of silver. The Mur. acid above therefore doubtful. Must examine this action more in detail and in a large way. Also make the fluid compound in close vessels and see if any thing given off. Where is the charcoal gone to?

CHLORIDE OF
CARBON AND
IODINE.

The same retort used as before—filled with nitrogen, 7 c: i: olefant gas let in.

CHLORIDE OF
CARBON.

26.5 c: i: chlorine which contained $\frac{1}{42}$ impurity exposed to sun—placed over chlorine and 10 inches entered—cooled to atmospheric temperature and 1 more entered.

Exposed to sun light for 1 h. and 30' nearly—then seemed quite dry and there was excess of chlorine—cooled—placed over chlorine and not quite half an inch entered.

Gases within	Oleft. gas	7	c: i:
	Chlorine (pure)	37.1	
	Air in it	.9	
	Nitrogen	1.5	

Then absorbed by solution of chlorine:

gas Absorbed 19.1 or 19.75

gas Unabsorbed 15.75 or 15.1; of this absorbed

by water 2.75 Nitrogen were left.

I suspect the action was not complete here, for the numbers accord no how otherwise; there are 7 Oleft. gas and 24.1 Chlorine used and there are about 19 M. A. Gas formed. It seems probable that about $\frac{2}{3}$ have formed the substance and $\frac{1}{3}$ the oil.

Look for hydrogen in the substance by sulphur, metals, etc. The action does not seem to have gone so far in this experiment as in that of the 6th or yesterday's.

Some oil; then put all into a retort and fill with chlorine. Afterwards see whether there be expansion or not.

Potassium burns brilliantly in the vapour of the substance

CHLORIDE OF CARBON. forming Chloride of potassium and charcoal. Inflammable gas is given out but it is difficult to tell whether it came from the Naptha, the water, the potassium absorbed from the air in cutting or the substance.

Phosphorus heated in an open tube with the substance formed a fixed red carburet of phosphorus and phosphorous and phosphoric acids; when the tube was washed out with water muriatic acid was found, so that chloride of phosphorus had been formed.

The phosphorus heated with it in a bent tube over mercury and without access of air formed red carburet of phosphorus, chloride of phosphorus and a little gas; the carburet burnt away in the air forming phosphoric acid. The chloride dissolved in water gave abundance of Muriatic acid and the gas was not inflammable. Much of the phosphorus unchanged.

Make this expt. again and see what the gas is.

Tried it again and the phosphorus this time inflamed in the vapour, leaving a thick film of carbon across the tube in the place where the flame had passed; the gas was absorbed by water, fumed with ammonia and precipitated Nit. of Silver; it was M. A. G. Is the hydrogen from the substance or the phosphorus on the water of Mercury? Chloride of phosphorus is formed plentifully.

Heated sulphur and the substance in an open tube: they soon combined with the precaution of heating the lower part of the tube highly and both chloride of sulphur and sulphuret of carbon were formed; the latter was shewn by the bright flame of the fluid. The former when decomposed by water gave abundant precipitate to Mur. Baryta and Sul. Silver.

Heated the same substances in a close tube over mercury: the mercury and the sulphur combined to form sulphuret, which confused the results, but a little sulphuret. hydrogen was formed.

A piece of box wood charcoal heated over mercury in the vapour: action on the mercury took place and the charcoal seemed as might be expected inactive.

Heated Iron in the vapour over mercury: when pretty hot the iron rapidly decomposed the substance and charcoal and proto chloride of iron were produced; there was a little gas produced

but it would not burn. The iron when turned out was covered with charcoal and chloride and the glass rendered opaque by the quantity of charcoal deposited. Repeat and examine gas by water. CHLORIDE OF CARBON.

Repeated—action as before—gas liberated partly absorbed by water—rest not combustible.

Repeated again—very little gas— $\frac{3}{4}$ absorbed by water—rest too small to try.

Heated iron over mercury alone and still found a little gas formed, probably from the water of the mercury; the Iron became tarnished.

Retort exhausted and 32.5 inches of Nitrogen let in. Capacity by measurement with water found to be 35.25 c: i:.

Exhausted as well as may be and 8 c: i: of olefiant gas let in; then also 8 c: i: of chlorine. Exposed to light a moment and then 4 c: i: more of chlorine let in (these 12 contain 7.2 per cent impurity)—then to light for 1 h. $\frac{1}{2}$.

On to chlorine and 17 c: i: entered (the impurity of this, $\frac{1}{30}$)—cooled and nearly 1 inch more of the same chlorine entered—exposed to light, cooled and nearly $\frac{1}{2}$ cubical inch of *air* entered.

The light seemed to act on this retort very tardily though chlorine was in great excess, as evident by colour. It was therefore left all the (8th) Sunday exposed to the sun, the day however not being very clear, though fine in the afternoon.

At the end of this process there was evidently some of the oil in the retort unchanged and excess of chlorine present. The crystals of the substance were large—no air entered when opened over chlorine—absorbed by solution of chlorine 20.5 inches M. A. G. were taken up and 14.75 + remained unabsorbed; these transferred and shaken in water were divided into 6.75 chlorine, etc., 8 inches Nitrogen, etc.

OCTR. 9TH, 1820.

Used the same retort as in the former experiments (Capacity 35.25 c: i:). Exhausted and let in 34.4 in. of Nitrogen;

exhausted and let in first 4 c: i: of Olef. gas

and 30.1 c: i: Chlorine;

impurity of the Chlorine 4 per cent.

CHLORIDE OF
CARBON.

Stood about 1 hour in dull day light and then absorbed 8 c: i: more of chlorine, the impurity of which was $\frac{1}{25}$.

It first stood stop cock upwards for some time and was then set upright with the cock and cap immersed in water. In this way it stood in the window the whole day and many crystals formed in it, though there was no sunlight; taken in in the evening and to be exposed tomorrow. ○

See Octr. 14th.¹

The absorbtion in this experiment just twice as much as the quantity of olefiant gas used.

Another retort used, its measured capacity being 35 + c: inches.

Exhausted and 34 c: i: of Nitrogen let in.

Exhausted and let in 10 c: i: of chlorine, its impurity 4 per cent.

Added 24 c: i: of Olefiant.

The cock and cap were immersed in water and the retort exposed to day light (no sun) from 9 A.M. to 5 P.M.—the fluid had formed and colour disappeared—placed over nitrogen and 15 c: i: entered—a little vapour of substance deposited on the side; it was left for half an hour and then scarcely a sensible portion more of nitrogen entered.

Examine the gas tomorrow. ◎ see tomorrow.

Another Retort prepared, etc. Its measured capacity inches.

Exhausted and let in 36.75 c: i: nitrogen

Exhausted and let in 12 c: i: oleft. gas

24.75 c: i: chlorine, impurity of chlorine $\frac{1}{25}$.

Immersed the cap and cock in water and left it in a dark cool place from 9 A.M. to 5 P.M.; fluid had formed, but no crystals—placed over chlorine and 21.5 inches entered, its impurity $\frac{1}{30}$ —after standing half an hour to let vapour deposit 1 full inch more of chlorine entered. ¶ See Oct. 11th.

All these retorts were left for the night with their cocks and caps under water. The results to be examined in the morning.

OCTR. 10TH, 1820.

◎ See yesterday.

The retort had stood all night with the cock and cap in water;

¹ Octr. 13th was intended.

this Mng. $\frac{1}{4}$ c: i: more of nitrogen entered—then some was thrown out by heat over mercury into a jar. The gas let free seemed to have no M. A. G. or chlorine in it; about $\frac{1}{12}$ was absorbed by water but the solution was not precipitated by Nit. Silver—lime water put into the gas was made very slightly turbid, probably from impurity in the Oleft. gas used (the Oleft. used in the former experiments seems to have been very impure, at least some of it).

CHLORIDE OF
CARBON.

The gas burnt from a jet nearly if not quite as bright as olefant gas and there was no muriatic colour about it after it had been passed through water (Query before).

Portions of it were put in four tubes and then chlorine added to it. The chlorine used had $\frac{1}{48}$ impurity. These were put on at 8 o'clock. A.M. Nos. 1 and 2 in the light in the yard, Nos. 3 and 4 in a dark place.

At $\frac{1}{2}$ past 8 o'clock. No. 1 was brought in and agitated in water to absorb the remaining chlorine; 39 vols. of gas had been put in, to which 73 parts of chlorine had been added, and the whole by standing and absorption left 27 vols. which were insoluble in water and incombustible with oxygen by a taper.

No. 2 was brought in at $\frac{1}{4}$ past 11 o'clock.; there were crystals of substance formed in the upper part. The chlorine was absorbed as before. 34 vols. of gas and 49 of chlorine left 30.3 insoluble in water and incombustible. The smell of this gas was very peculiar and acrid, a little like chlorine.

No. 3 was at $\frac{1}{2}$ past 11 brought out of the dark place—there were no crystals—the Chlorine was absorbed—40 vols. gas and 50.7 chlorine left 25.2 like the last.

No. 4 was brought out at $\frac{1}{4}$ to 12 o'clock.—treated as before. 20.7 gas with 60 chlorine gave 15.1 insoluble and incombustible—this washed in potash (sol.) lost almost entirely the acrid smell; probably therefore it was due to a little adhering chlorine.

Hence tube No. 1 indicates for 100 vol. of gas 69.23 residue

”	2	”	”	”	88.53
”	3	”	”	”	63
”	4	”	”	”	75.5

as a mean 100 parts yielded 74.065.

CHLORIDE OF
CARBON.

There had been introduced into this retort which held 35 + c: i:

1.0 Nitrogen	} or generally	24 Oleft. gas
9.6 chlorine		9.6 chlorine
0.4 impurity		16.4 Nitrogen
24.0 Oleft. gas		50.0
15.0 nitrogen		35

The diminution in bulk by condensn. 15

Of the 35 + remaining in nearly 3 c: i: were absorbed by acid and the 16.4 nitrogen may be supposed to remain; this leaves space for 15.6 Oleft. in excess. But a residue of this kind would leave 51.25 per cent instead of 74.065 as above.

To Examine the method of separating Oleft. by chlorine and also to repeat the expt., testing the Oleft. before hand.

Put more of the gas with chlorine into three tubes; impurity of the chlorine $\frac{1}{40}$. They remained thus till next Mornng. when all the chlorine seemed gone.

No. 1 had received 21 vol. of gas and 70.75 of the chlorine; 17.7 of nitrogen remained.

No. 2 had had 20.3 of gas and 63.7 chlorine; 17 of nitrogen remained. These two had been left in the dark.

No. 3 had had 19.75 gas and 80.75 chlorine; 13.6 of nitrogen remained. This had been placed in the light till Eveng. came on (dull day) and the tube was lined with crystals of the substance.

Nos. 1 indicates for 100 of the gas 84.3 residue

No. 2 " " " 87 do.

No. 3 " " " 69 nearly, or corrected for impurity of chlorine 58.7 nearly; this comes near the 51.25 required by Yesterday's calculation.

Octr. 11th Mornng.

OCTR. 11TH, 1820.

Retort with chlorine in excess. See Oct. 9th. $\text{\textcircled{C}}$. Yesterday Afternoon this retort was opened over nitrogen and half a cubical inch entered. It was then placed away in water in a dark place again till this morning.

A portion of this gas equal to 92 vols. was thrown out by heat into a jar over mercury yesterday and being well shaken left to

stand all night to absorb the chlorine, which absorption amounted to 62.4 C; then 7.4 of M. A. G. were taken up by water and 22.2 of Nitrogen left—the 92 vols. equal 2.5 cubical inches. CHLORIDE OF CARBON.

Then this morn'g. the M. A. G. in the retort was absorbed by sol. of chlorine; the absorption amounted to 11.5 c:i:, but of this, 2.5 c:i: apparent only, being the quantity thrown out by heat yesterday; 9 c:i: therefore of M. A. G. The unabsorbed part = 25.75; of this 22.75 were chlorine and 3 Nitrogen—the whole measured capacity being 37.25.

It is to be observed that on adding water the peculiar substance became evident. It is therefore formed in the dark by excess of chlorine.

The air in the retort gives by Mercury, etc.

25.26 c:i: chlorine

3 M. A. Gas

9 Nitrogen;

by water

24.38 chlorine

9.65 M. A. G.

3.216 Nitrogen.

Query the reason of this difference. I can trust to the last as to the nitrogen and to both as to the chlorine nearly.

Hence therefore the Olef. nearly pure in these experiments.

Hence also the substance forms in common day light in crystals.

Hence also it forms in the dark with excess of chlorine.

Precaution in getting substance pure: distil it, it must leave no black mark—wash it in alkali—dissolve in Ether—dry it over Sulphuric acid—dissolve in Ether and test by N. of Silver for any adhering Mur. acid.

Tried the substance thus prepared and got very little gas from it by sulphur or Iron (not appreciable) and though more by phosphorus, yet varying with different portions of the substance as if accidental.

Electrised it by shock over mercury, 400 pl. Charcoal deposited and chloride of Mercury formed—a very minute globule of air

CHLORIDE OF set free, apparently from impurity or some circumstance in the
CARBON. expt. Experiment favourable.

Sir H. Davy present.

Heated it with potassium; gas given out, but seemingly from the Naphtha, etc.

Sir H. Davy present.

Try with Zinc over mercury same way.

Repeat Electrical Experiment.

Make expt. in small retort on gases, absorb the chlorine by Mercury, etc.

OCTR. 13TH, 1820.

○ See Octr. 9th.

This retort has stood in day light since Monday, and yesterday it had sunshine. There were many crystals in it but in one place appearance of a little moisture just at the bottom of the bulb; the cock has been all the time in water and probably this is a little that has entered since monday.

Being placed over chlorine 1 c: i: entered, occasioned I suspect by the absorption of Mur. acid by the fluid. Some was then thrown out by heat over mercury and then the two portions examined to see what they left. When the retort was cold it was again placed over chlorine and 2.65 c: i: entered.

Then being treated by sol. of chlorine

13.25 c: i: were absorbed for M. A. G.

20 c: i: were chlorine and

1.75 were Nitrogen and air,

but 2.65 of the chlorine were admitted just above, therefore the real proportion will be 14.305 M. A. G.

18.787 Chlorine

1.893 Nitrogen, etc.;

to this add the inch of M. A. G. absorbed in the retort and it will be nearly 4 times as much as the Oleft. used.

Calculated quantity of gases put in

4 c: i: Oleft.

37.58 chlorine

3.15 impurities.

The chlorine here nearly 5 times the Oleft. gas used.

The portion thrown over mercury and analysed first by having the chlorine absorbed by the mercury, and then the M. A. G. by water, gave for 41·5 vols. CHLORIDE OF
CARBON.

23·9 Chlorine

14·2 M. A. G.

3·4 Nitrogen, etc.;

this would give for 35 c: i:

20·157 c: i: chlorine

11·976 c: i: M. A. G.

2·867 impurities.

There is a chance that absorbed M. A. G. by sol. of chlorine. The absorbtn. seems greater than it ought from the absorption of chlorine at the same time.

Try it over Mercury.

Does Mercury readily absorb chlorine gas from M. A. Gas or nitrogen—try.

Took a small retort, measured capacity 7·5 c: i:.

Into this full $\frac{1}{2}$ cub. inch of oleft. and 6·5 of chlorine, unknown purity; exposed to bright sunshine for 2 hours, then 3 c: i: more of chlorine entered—then to the light again and in the afternoon open'd the cock under Mercury. There was an immediate ascent up to a mark = 1·25 c: i: . Then absorbed the chlorine by the mercury and the chlorine amounted to 4·85 c: i: . Afterwards absorbing the residual gas by water it gave ·8 c: i: M. A. G. and ·6 Nitrogen, etc. Query is the absorption of 1·25 owing to M. A. G. condensed. If so, it must be added to the ·8 and would be nearly what I expect.

Good mode of experimenting: repeat it.

Took a large retort; let in

4 c: i: oleft.

28 c: i: chlorine. Then to sun light; open over mercury and 8 c: i: more entered—light again, then $\frac{3}{4}$ c: i: of chlorine entered.

To be examined.

Took three tubes—put in oleft. up to mark and then filled up with chlorine containing only $\frac{1}{48}$ impurity (2·5 to 1 about). 2 of these were placed in strong lamp light and in a few minutes the absorption was equal to twice the bulk of the oleft. gas. They

CHLORIDE OF CARBON. were left in the light. The absorption afterwards went on very slowly. Hence equal vols. of olef. and chlorine form the oil.

The third was put in a dark place; the absorption immediately took place up to twice the bulk of the olef. and then went on very slowly.

By 11 o'clk. P.M. (the gases put in at 7) all had disappeared except the impurity of the chlorine a very little augmented. No difference was visible between those in the light and that in the dark.

Put some of the substance into Olef. gas and sublimed it but it did not change it.

OCTR. 14TH, 1820.

Took three small retorts and prepared them. Then let into No. 1 = 11.5 of Nitrogen. Afterwards exhausted and put in 1 c: i: Olef. gas and 10.25 chlorine, its impurity $\frac{1}{48}$. After $\frac{1}{2}$ an hour 2 c: i: of chlorine entered. Put into water and placed in light till Eveng.; little sun in the day time.

See Octr. 16th.

No. 2, let in 11.75 c: i: nitrogen, then exhausted and put in 1.4 c: i: olef. + 10 chlorine—stood half an hour, then 2.75 c: i: chlorine entered—placed in light as above.

See Octr. 16.

No. 3, let in 12 c: i: of nitrogen—then 1 c: i: olef. + 10.5 chlorine—stood $\frac{1}{2}$ hour—2 c: i: more chlorine—in light as above.

See Octr. 17th.

Barometer 30.1.

In the Eveng. the conversion seemed nearly if not quite perfect, but appearance of a little dampness within. Nos. 1 and 2 brought down, No. 3 left out till Monday (Oct. 16th).

No. 1 placed over chlorine: none entered. Mercury introduced and absorption of the chlorine allowed to go on all night.

No. 2 over chlorine: $\frac{1}{2}$ c: i: entered—placed over Mercury to absorb as above. See Octr. 16th.

Distilled a little of the substance through a red hot glass tube; gave out chlorine and became converted into a fluid body at common temperatures; no carbon deposited. Query Proto-chloride—electrised it but it was a perfect insulator—put a little

of it into chlorine, but it did not seem to absorb it—was very volatile. Sir H. Davy present. CHLORIDE OF CARBON.

This fluid may be formed by merely heating the bottom of a tube containing a little of it; the substance soon becomes the fluid.

Passed some of the solid *substance* over rock crystal heated bright red hot in a glass tube. Much of the *fluid compd.* came over, a little coloured as by charcoal; and also chlorine gas almost entirely soluble in water. The crystal.*

Passed the substance over red hot oxide of Zinc: almost entirely decomposed. Chloride of Zinc was formed and charcoal deposited in the tube with it: a very little of the fluid compd. came over and carbonic acid and carbonic oxide gases in the proportion of 25 C. A. to 14 C. Ox.

The crystal in the tube above * blackened in one place slightly by deposition of charcoal, which formed a bright surface on it and burnt off by exposure to heat—some of a solid substance had passed. The fluid turned down into the lower part of the tube and this solid substance heated to make it volatilise and descend too. It condensed again in part on the sides of the tube but the quantity was very small—crystallised on cooling on the sides and the crystals formed curved lines apparently more fixed than *the solid substance*. A small portion scraped out seemed also more combustible—burning out of the flame of the spirit lamp something like camphor and giving much charcoal. Query is this the solid substance pure or any thing else? PROTO CHLORIDE OF CARBON.

What I have generally taken by its appearance for moisture is I fancy the fluid substance—sublime the whole and separate the lower parts as most pure. Convert the upper into the fluid.

OCTR. 16TH, 1820.

Passed chlorine from a bladder over charcoal heated red in a white glass tube. The tube was acted on but the charcoal apparently not, except in forming a little phosgene gas and carburetted hydrogen. M. A. Gas, water and light hydrocarbonate with chlorine came over. CHLORIDE OF CARBON.

Passed the substance (solid) over Iron in a white glass tube. Chloride of Iron formed, charcoal deposited and a little inflam-

CHLORIDE OF mable gas came over. As the tube was acted on, query carbonic
CARBON. oxide?—detonated: *was carbonic oxide*.

Then 5 grain of the crystals were again passed over Iron in a white glass tube. Nothing came over but gas and a very minute portion of water: the gas = 15.5 parts altogether, common air and all being received; but another equal tube heated in the same way gave out 5.5 parts from expansion of the air; therefore 10 the quantity of gas given out by the substance. 36 of these parts = 1 c: i: therefore 5 gr. gave out .28 of a cubical inch. A part of these seen to burn like carbonic oxide—detonate the rest and ascertain its nature; oxygen from the glass. It was carbonic oxide. © See Octr. 17th.

The two small retorts of Sat., which had stood over Mercury since then, were Nos. 1 and 2.

No. 1. Mercury had risen in the neck and stood at Mark—13.5 inches above the level on the outside. Barometer 29.3.

Mercury in the neck up to the mark equalled 3 c: i:. The expanded M. A. G., Nitrogen, etc. equalled 8.5 c: i:. This absorbed by water gave at common pressure .8 + c: i: of nitrogen, etc. Hence the corrected quantities are: Nitrogen .8 +, M. A. G. 3.668 c: i:, Chlorine 7.032. Good Expt.

The retort No. 2. Mercury stood up at Mark—11.1 inches above the surface in the trough, at Barom. 29.3.

The Mercury up to mark = 2.3 c: i:

Expanded M. A. G., nitrogen, etc. = 9.45
unabsorbed Nitrogen .65 c: i:.

The corrected quantities of gas are M. A. Gas 5.429 c: i:, Nitrogen .65, Chlorine 5.571. Excellent Expt., both came out very near.

Passed 5 grains more of substance over Iron turnings. The quantity of gas in this expt. less than before, but not measured—detonated the last portion of it with oxygen over mercury. About half a volume of oxygen disappd. and a vol. of carbonic acid gas remained; this absorbed by potash and the remainder found to be oxygen in excess.

Gas therefore Carbonic oxide. No fluid substance came over

and the gas passed into Nit. of Silver caused no precipitation—
good expt. CHLORIDE OF CARBON.

Get the chlorine from the chloride of Iron.

By acting by acid (Nitric) on the Iron of these experiments.

□ See tomorrow.

O C T R. 17TH, 1820.

Made some more of the fluid or proto chloride. It is more combustible in the air than the perchloride, giving out much carbon and a smell somewhat resembling Phosgene gas. It is heavier than water and looks like an oil at the bottom of it; heated in [it] it is converted into vapour before the water boils—and is the cause of the same appearance sometimes in the solid substance. It is very volatile, rising from the hand like Sul. of Carbon. PROTO-CHLORIDE OF CARBON.

Solid Chloride put into a retort with Ammoniacal gas and sublimed—no change—send them through a hot tube together. CHLORIDES OF CARBON.

* Fluid chloride put into chlorine in retort heated with lamp in common day light (7 o'clk. A.M.): apparently no action immediately—expose to light and see absorption of the chlorine. On the Morn'g. of the 18th nearly an inch of chlorine entered and crystals seemed slowly forming—still in light. See Octr. 20th.

Fluid chloride put into Ammoniacal gas, dry. At first slight action in consequence of the adhesion of chlorine to the chloride. After, the fluid remained unchanged and on placing the retort over amm. gas there was scarcely a perceptible absorption. On the 18th scarcely a perceptible absorption—still in light. See 19th.

When sublimed the solid chloride looks beautiful on the inside of the tube, forming a transparent body, crystalline and splitting like camphor. It soon becomes opaque on cooling.

Decompose perchloride and ascertain chlorine given out by precipitation of it.

Today had a considerable quantity of the olef. oil in the large alembic head—filled the head with chlorine—placed it in sunshine—the whole converted into M. A. Gas but no change of volume.

□ The acid used to assist to dissolve the chloride of Iron left

CHLORIDES OF
CARBON.

a black powder: consists of a plumbagenous powder looking like charcoal and being a compd. and mixture of Carbon, Iron and glass—the carbon when heated burnt off leaving oxide of Iron.

Now See Octr. 16th. © The Iron turnings, chloride, etc. with the tube were taken and washed with water and then with a little N. A. to dissolve all the chloride. The solution carefully precipitated, dried and weighed gave 16.4 gr. of chloride of Silver = 4.05 chlorine from 5 gr. of the substance—but some of the chlorine has been taken by the glass tube, as evident by the Carbonic oxide.

The second expt. of the same kind □ gave 21.3 gr. of dry chloride of silver, but this was not pure; it contained some fragment of oxide of Iron and Iron. This chloride was reduced though imperfectly by Zinc in the moist way and then the Chlorine again obtained from the Zinc by silver; it now weighed 15.5 gr., but this of course too little.

The retort No. 3 (Octr. 14th). This Mng. looked at—there were a few spots of Moisture either of water or proto chloride within, which I expected would absorb M. A. G.; and placed over chlorine .85 of cub. inch entered.

The chlorine was then absorbed by Mercury and left standing over it till this evening. The Mercury then stood up to Mark—12.9 inches above the level in the trough and Barom. 29.05:

Mercury up to Mark	3.5
Expanded M. A. G. as Nitrogen, etc.	8.25
unabsorbed Nitrogen	.75
Corrected quantities with Absorption, etc.	
Chlorine	7.325
M. A. Gas	4.327
Nitrogen	.75

Very near.

PROTO CHLORIDE
OF CARBON.

Potassium burns brilliant when heated in the vapour of the proto chloride of carbon but does not act immediately on the fluid when dropd. in without heat be applied. It form[s] Chloride of potassium and deposits charcoal.

The fluid proto chloride put into solution of N. of Silver and washed with it so as to separate the chlorine it had dissolved, remained afterwards for several hours (8) in it without any action or decomposition; or even in days.

The solid will not burn with chlorate of potash but rises un-
 altered from it unless it be confined so as to heat the vapour red
 in the oxygen.

PROTO CHLORIDE
 OF CARBON.

OCTR. 18TH.

Distilled 5 gr. of solid chloride through a red hot tube heated
 by lamp and received the gas into Nitrate of silver—then washed
 the fluid and vessels with the same sol. and collected the chloride
 of Silver: it equalled 2.6 gr. = .64 gr. chlorine. Irregular.

CHLORIDE OF
 CARBON.

Form Proto chloride by phosphorus, wash and get the
 Chlorine.

A retort was prepared and filled with Nitrogen = 37 c: i: then
 introduced a little of the Naptha substance and filled it with
 chlorine, impurity about $\frac{1}{28}$. Immediately on coming into contact
 there was an action and heat evolved. The substance fumed,
 effervesced and then solidified. On placing the retort over
 chlorine again there was absorption of 1.4 c: i:—put into sunshine
 (fine day) and left till the evening—then 1.6 more of chlorine
 entered.

NAPHTHOLINE AND
 CHLORINE.

The solid substance does not look like perchloride of Carbon,
 not being so crystalline and appearing moist. When the retort
 was opened there were abundant fumes of M. A. G. These and
 the chlorine were blown out and the substance examd. It was
 tenacious and adhesive to the spatula—dissolved in Alcohol and
 precipitated by water—fused and then volatilised but not so readily
 as the perchloride. Its smell somewhat resembled a mixture of the
 Naptha substance and the perchloride; when sublimed it did not
 condense like the perchloride but was partly decomposed and
 became coloured, and at a higher heat became bituminous, giving
 out M. A. G. and at last left a charcoal behind. Is almost certainly
 a mixture of Naptha substance and something else, but doubt
 about its being the perchloride. The body has evidently lost
 hydrogen and apparently, nay certainly, gained much chlorine.

A retort prepared and 24.25 c: i: of Nitrogen introduced. Then
 5 c: i: of olef. gas and 10 c: i: chlorine: set aside for half an hour
 and then 19.25 more of chlorine let in, which just filled it, the
 diminution having been 10. Barom. 29.1. It was then placed in
 sunshine for the day—the solid formed and very little fluid seemed

CHLORIDE OF
 CARBON.

CHLORIDE OF CARBON. remaining; nevertheless when placed over chlorine not the slightest change in volume produced. Excellent.

The impurity in this chlorine about $\frac{1}{28}$ th. Have placed the retort over Mercury to absorb the chlorine. Leave it till the Mornng.

See to-morrow. C.

The pure perchloride heated in an open tube with phosphorus: the latter inflamed in the vapour, burning brilliantly and depositing charcoal, and being in excess formed proto chloride of Phosphorus. A portion of the chloride of carbon is converted into protochloride, but this is decomposed when it comes with the phosphorus in vapour into the hot part of the tube.

Heated over mercury. The same series of decompositions ensue when the temperature of the vapour is sufficiently raised, and sometimes the phosphorus inflames there.

Phosphorus put into Alcoholic solution of the substance seemed to produce no effect on it—test for M. A. tomorrow.

Phosphorus mixes and dissolves in it.

CHLORIDE OF CARBON AND SULPHUR.

Sulphur melted with it readily dissolved with it and the two crystallise on cooling into a yellowish mass. On being heated the substance rises unchanged and leaves the sulphur also unaltered, but when the mixed vapours are heated more highly there is decomposition. Abundance of chloride of sulphur is formed and proto chloride of carbon. Sometimes there are appearances as if a carburet of sulphur were formed but I have not satisfied myself.

AND IODINE.

When a small quantity of Iodine is heated in a tube with the substance the vapour of the colour of iodine soon disappears, apparently as the perchloride becomes proto-chloride, and the mixture which is very intimate remains fluid generally at common temperature unless there be too much perchloride left. Water poured on to the Mixture generally liberates iodine and reproduces the colour of the vapour when heated; and the solution obtained, being first heated to drive off free iodine, then contains chloride, acid and precipitates both iodide and chloride of silver from solution of silver.

The decomposition of the perchloride by the iodine does not seem complete.

The protochloride readily dissolves iodine and form[s] a beautiful red solution like those made by Alcohol of Sulphur, Chloric Ether, etc. AND IODINE.

Made some protochloride by passing it twice through a red hot glass tube. Still it was far from perfect decomposition, for on evaporation it left the perchloride beautifully crystalline. The proto chloride dissolves a good deal of the perchloride. PROTO CHLORIDE
OF CARBON.

The protochloride (not quite pure) dropped on a thermometer bulb sank it only from 62° to 56° , yet its evaporation seems rapid. Perhaps the capacity of its vapour for heat is very small.

The fluid proto chloride seems to decompose water though very slowly. When boiled many times successively for several days in the same portion of water a small bubble of gas was given off, apparently carbonic oxide, and the water very slightly precipitated with Nitrate of Silver. Perhaps also Carbonic acid was formed and dissolved; at least that would from its composition be expected.

1820. OCTR. 19TH.

Phosphorus put into Alcoholic solution of the perchloride does not act on it in 24 hours nor does there appear any commencement of action. PER CHLORIDE OF
CARBON.

Sol. Ammonia added to the alcoholic solutn. of it makes it dissolve less ammonia, and the same is to a certain extent with potash, the substance crystallising when cooling in greater quantity. There does not appear to be any action on the chloride though after many hours the alkalies are found to contain a very small quantity of chlorine.

See Yesterday. ¶ The retort left over mercury all night now examined: the Mercury stood up at Mark—6 inches above the level on the outside and Barometer 29.6. Then the Mercury which occupied that part = 1.25 c: i: . The unexpanded Nitrogen = 1.2 and the expanded M. A. G. and Nitrogen = 24 c: i:

Hence true Vols.

Chlorine	.	.	.	.	5.78
M. A. Gas	.	.	.	.	18.27
Nitrogen	.	.	.	.	1.2

PROTO CHLORIDE
OF CARBON.

See 17th. The proto chloride in ammonia still seemed to remain for the great part unchanged; there was a slight absorption but the retort this Mg. was very cold. The action seems slow only like sol. of Ammonia.

NAPHTHOLINE AND
IODINE.

A retort exhausted and some Naptha substance and Iodine introduced: excess of latter. Mix by heat but apparently no action—exposed to light—the two bodies crystallised here and there separate from each other and without any action having happened. Opened over Mercury; it rose entirely and only left the quantity of air not taken out by the pump; therefore no gas formed.

HYDROCARBURET
OF IODINE.

Yesterday Mng. a retort was got ready—exhausted—let in 11.25 c: i: nitrogen—put in little Iodine and then 11.25 Olef. gas—exposed to light all day. Today colourless crystals had formed on the glass like little speculae and the colour of the iodine had in a great measure disappeared—did not touch the inside of the retort, but on heating the part where the crystals rested they fused, and on cooling the fluid crystallised again. Heated more highly the substance sublimed and condensed in the upper part in beautiful plates like body from Naptha.

Some parts were coloured brown and on heating these iodine rose and stained the other parts. Crystals very beautiful on the inside of retort. Drove the iodine about and then exposed again to light. In the Afternoon placed over Olef. gas—1.5 c: i: entered—then threw out a little of the gas by heat over mercury and found it to contain no hydriodic acid gas, there being no fumes in the air nor any absorption by water, and the gas burnt as Olef. The substance most probably a compound of Olef. gas and iodine analogous to chloric Ether.

See 23rd.

NAPHTHOLINE AND
CHLORINE.

A grain of Naptha substance put with 9.2 c: i: of chlorine into a retort—the substance immediately heated, fused, effervesced and became solid—exposed to light for the day. Then placed over chlorine—4 c: i: entered and afterwards Mercury being admitted it nearly filled the retort. Try again for quantity of M. A. G.; very small and perhaps from the Naptha.

Passed 5 gr. of the solid chloride through a tube containing peroxide of copper and heated red hot; gas came over and was recvd. in *tubes* over water; its quantity amounted to 2.6 c: i: . 49 parts absorbed by potash left $4.5 = .0906$, and these were a mixture of carbonic oxide and common air—hence the 2.6 c: i: were 2.36 Carb. Acid and .24 Carb. oxide and air—these are = to .303 gr. carbon. See how much chlorine in the copper. It gave 15.8 chloride Silver = 3.9. Too little carbon, too much chlorine.

PERCHLORIDE OF
CARBON.

In this experiment a small portion both of the solid and fluid chloride came over unchanged, but it was not in great quantity and could not much interfere with the result. Repeat the Expt. over Mercury.

Try the fluid chloride this way but get it pure first.

See Octr. 17th. * The retort has been left in the light since then. Now there was no farther absorption, the quantity of fluid chloride seemed lessened and there were many crystals about of the solid chloride; but as the fluid always as yet has contained the other dissolved they may then have been introduced. On the whole I think there is a slow reconversion back into solid chloride. Try again. From the quantity of impurity left by absorbing chlorine in the retort common air seems to have entered. The absorption therefore greater than it appears.

Endeavoured to detonate with oxygen and also with hydrogen in the detonating tube (solid chloride in vapour) but could not succeed by strong electric sparks, in consequence of the heat of the mixture not being high enough by Spirit lamp. When heated with chlorate of potash or peroxide of Mercury it frequently burns in the oxygen.

5 Grs. per chloride sent through a green glass tube heated bright red for about 5 inches and the products received in sol. of Nit. Silver—a little solid chloride still came over—then collecting the chloride of Silver formed and drying it, it weighed 2.5 gr. = .615. This is nearly the same as the last and gives about 3 parts decomposed and 4 undecomposed. Supposing that the per chloride loses 1 proportional of chlorine. Try again with crystals in green tube.

Put a little ether in a tube into a bottle of chlorine and left it all night. There was no immediate action though the ether was

ETHER AND
CHLORINE.

ETHER AND shaken out of the tube. Next Mng. there was Much M. A. Gas
CHLORINE. formed and a fluid body which sank to the bottom of the small
portion of water remaining in the bottle. Query Chloric Ether.

Try with Ether, a little water and chlorine in sun light and also
try in a dry retort.

21 OCTR.

VAPOUR OF Put the *gold* with *Mercury* into a tube and a bottle very care-
MERCURY. fully and then set them aside in a dark place for convenience sake.
PER CHLORIDE Put some per chloride 2 or 3 days ago into an atmosphere of
CARBON AND hydrogen and exposed to sun light. When sublimed at first no
HYDROGEN. effect seemed produced, but now if sublimed a thick fluid is left,
apparently rather fixed and tenacious—sublimed the substance
about and left it for sun light again. *

OCTR. 23RD.

The solid chloride was put on Sat. Mng. into an atmosphere
of Carbonic oxide and exposed to sun light through the day; and
in common light yesterday. This morning no change had taken
place. Nor when sublimed was any effect produced. No phos-
gene gas formed or chlorine separated.

* This Mng. I placed this hydrogen retort over air; there was
a very little absorption, hardly appreciable. The fluid was very
evident here and there in small drops but a great quantity of the
solid chloride remained and very much hydrogen. On opening
the stock cock fumes of M. A. Gas appeared and very abundantly
with Ammonia. It was placed neck downwards in water to absorb
the M. A. Gas. Not more than half cub. inch was absorbed in
12 hours. The retort was then cut open and the apparently thick
fluid found to be nearly solid but not at all crystalline. It was
very adhesive and apparently not very combustible. When
Alcohol was poured on to it it became white and slightly opaque,
perhaps from the Alcohol dissolving out the perchloride mixed
with it. It is in very small quantity and its nature seems doubtful.
See the Evening. ○

PERCHLORIDE Some of the solid chloride was put into Nitrous gas some days
CARB. AND N. GAS. ago and has been exposed to heat and light, but no change has
taken place.

Put some of the substance into Nitrous acid gas and sublimed. There appd. to be no action, and the nitrous acid when dissolved by water and tested by Nit. of Silver gave so faint a cloud that it did not seem to have taken any of the chlorine from the substance. The substance remd. in the water and with its usual smell just as it would have done without any action of the gas.

PERCHLORIDE CAR-
BON AND NITROUS
ACID GAS.

On the 20th I put some Naptha into an atmosphere of chlorine in a retort; this was done in the evening. On the entrance of the chlorine the Naptha began to boil and heated considerably and there appeared to be absorption, but that might be from the cooling—expose to light tomorrow. 21st. In the evening looked at it—colour of chlorine nearly gone. Naptha thick and tenacious. Put over chlorine, absorption, and 5 c: i: entered—expose to light tomorrow. 23rd. Chlorine colour nearly gone. Naptha very thick but colourless—again placed over chlorine and 22 c: i: entered—the water had cooled the cock and cap and some of the contents had distilled over to that part. This when the gas entered was thrown up in a fluid state and green from copper, but soon solidified from the chlorine, at least in part. A little water seems to have entered or rather I think to have been formed, for the under part of the cock was dry.

NAPTHA AND
CHLORINE.

See 19th. Prepared a retort and put in 6.55 c: i: nitrogen (its contents by air pump) then a little Iodine and 1 c: i: of Oleft. gas—little common air—sunshine. On the 20th. Crystals had formed as in No. 5 and had exactly the same appearance and properties—drove about the iodine and set it in the light—a little entered by the stop cock. On the 21st. white crystals as before—much of the iodine remaining—placed over oleft. gas, 5.25 c: i: entered—then opened—the water that had leaked in not acid and no hydriodic acid formed. Sol. of potash put into the retort and the iodine dissolved out, leaving the crystals.

HYDRO CARBURET
OF IODINE.

The retort of the 19th was now worked upon; the substance was fused down all together, then left with solution of potash all night and next Mng. the substance from both retorts collected together.

The substance is white or colourless—solid—crystalline in needles either by fusion or sublimation—transparent—of a sweet taste—aromatic smell—biting on the tongue, especially when

HYDRO CARBURET
OF IODINE.

dissolved in Alcohol—not soluble in water—heavier than water—not affected by solution of potassa—not readily combustible—readily soluble in ether and crystallising from its solution—fuses before it volatilises—requires a moderately high heat for its sublimation, that of camphor perhaps—crystallises from its ethereal sol.

NAPHTHA AND
CHLORINE.

The Naptha retort of this Mornng. placed over air this evng.: 5.5 c:i: entered and the water appears more evident—opened, there was plenty of M. Acid in solution and as gas—then water was poured in—the Naptha did not dissolve in it and seemed inclined to float, but at last several globules of it collected at the bottom and it was evidently rather heavier than water. The water decanted off and alcohol introduced, it dissolved a small portion of the white substance by heat, which by evaporation and precipitation by water was separated again. Ether dissolved it more readily and again deposited it by evaporation. The taste of the solution was very acrid and biting, etc. The Alcoholic and Etherial solutions put together and slowly evaporated deposited at first flocculi which soon aggregated into a thick tenacious gummy substance, having no taste, burning with difficulty, but then when in the flame of the lamp giving out charcoal and M. A.

When heated in a tube it was partly decomposed, leaving a heavy residue, and a coloured fluid rose (query fluid chloride of Carbon) burning with a much redder and denser flame than before. The solution seems to contain some principle different to that which deposits, for it is very sapid whilst the other is insipid. It is slightly acid also, but that is from M. A. To be examined into. ✧

PERCHLORIDE
CARBON AND
HYDROGEN.

See this Mng. ○ The substance left undissolved by the Alcohol is a dry pulverulent powder insoluble in it and water but very soluble in ether and thrown down from it by evaporation as a powder again. The alcohol was left to evaporate spontaneously all night and left a small portion of a white powder or rather substance which in burning tinged the flame of the spirit lamp blue and gave off charcoal. When the remains of it were heated in a capsule much M. A. rose, giving fumes with ammonia, and the capsule remained soiled by charcoal.

There ought to be another chloride containing more chlorine, and my solid chloride should be a compound of this and the proto chloride: CHLORIDES OF CARBON.

the proto	.	.	.	.	.		
per	.	.	.	.	.		this wanting
intermediate	.	.	.	.	.		this I have

Examine the apparently more fixed body before observed.

Make fluid chloride by heating bottom of tube and then see whether it contains solid perchloride .

Heat my solid chloride in chlorine in sunshine.

Get the fluid pure by distilling in close tube by the cold of ether or water evaporation.

Heat the fluid again with chlorine and see what the crystals are.

Query: is the Naptha body by chlorine the perchloride or that from Naptha substance.

Combine these with fluid chloride and see if they crystallise.

Carbon added to bodies often gives volatility: Sul. of Carbon, Carbonic oxide and acid, Carburetted hydrogen, Cyanogen, etc.

✧ Examined some more of this substance—was the same as before, giving off much M. A. G. and leaving abundance of charcoal in the tube, difficult of maceration. This was passed through a red hot tube. Mem. to examine the gas given off with the Mur. Acid gas and see what it is. NAPTHA AND CHLORINE.

OCTR. 24TH, 1820.

Put some perchloride into an atmosphere of Sulphuretted hydrogen gas, sublimed it within and exposed it to sun light, but no action. PERCHLORIDE AND SUL. HYDROGEN.

Passed some of the perchloride through a green glass tube filled with broken rock crystal and heated red—the object being to form the fluid. There was no charcoal deposited but only the fluid and chlorine. The chlorine bleached litmus paper held in it. The fluid was of a slightly yellow colour and contained dissolved much chlorine, so as to give it off by the warmth of the hand only—being heated the chlorine rose in abundance from it and when that was driven off, the substance itself rose by increasing the heat—it then became much more pale—was not so volatile— PROTO CHLORIDE OF CARBON.

PROTO CHLORIDE OF CARBON. deposited a few crystals—did not act at boiling temperatures on Zinc or carb. lime—Nit. of Silver does not act on it in a week or two—nor water, etc.

PERCHLORIDE CARBON. 6 gr. of the solid per chloride were sent through a white glass tube heated red and the gas recvd. in nit. of silver. The fluid was then redistilled into Nit. of Silver carefully and all the parts of the tube washed out with it; 3 grs. of dry chloride of silver were obtained.

Want green glass tubes.

OCTR. 26, 1820.

PROTO CHLORIDE OF CARBON. Distilled some of the proto chloride, obtained by passing over crystal, by hot air at a gentle heat in a tube, to separate it if possible from any thing else; was 8 or 10 hours going over and then about half had passed; this being separated the rest was set on again, but distilled very slowly, and in 14 hours had scarcely sent any over—it is now much more fixed, perhaps from the accumulation of solid chloride in the portion left—put to cool.

RESIN IN CHLORINE. Put some resin last night into an atmosphere of chlorine—no action at common temperatures either in or out of light. When heated the resin fumed, a fluid like water condensed within the glass—M. A. Gas fumes played about, the resin blackened and in some spots inflamed, depositing charcoal. It was rather difficult to melt and more resembled thin cheese than resin. It blackened, etc. when heated and no ready or definite decomposition seemed effected.

Results do not promise much.

NAPHTHA AND CHLORINE. Have put some more Naptha with water and chlorine in the light—the results as yet the same as before.

CHLORINE AND OIL OF TURPENTINE. Passed a current of chlorine into a quantity of oil of turpentine: it was readily absorbed and fumes of M. A. Gas arose. No chlorine passed free through the oil of turpentine. The vol: considerably increased and at last the oil heated and became brown, but the flask was now exhausted of chlorine and was taken away to be recharged with a fresh Mixture—then the action went on and at last the oil thickened from the formation of artificial camphor. The action on the whole similar to that in the retort below.

Put some oil of turpentine into a retort and then filled with chlorine—much heat generated and then slight inflammation forming Mur. Acid Gas and charcoal. Placed over chlorine again there was absorption and fresh heating but no inflammation—then there was very little farther absorption till water was let in to absorb the M. A. Gas formed, but afterwards fresh chlorine entered and the action went on as before—on again letting Chlorine in the action was much diminished—to be placed in light.

CHLORINE AND OIL
OF TURPENTINE.

Passed M. A. Gas through oil of turpentine. Artificial camphor formed, the gas being rapidly absorbed. Obtained the camphor by filtration.

ARTIFICIAL
CAMPHOR.

OCTR. 28TH, 1820.

Passed 5 gr. of solid chloride through a white glass tube over oxide of Zinc mixed with Zinc—but the tube melted and burnt so expt. incomplete—the gas that came over was nearly all carbonic oxide—but on examining the interior of the tube there was much charcoal deposited which I got out by Mur. Acid—and I found that the chlorine could be got with the greatest facility from the Zinc by N. A. and N. of Silver. The process will not do for the gas—but it promises well by oxide of Zinc.

PERCHLORIDE OF
CARBON.

Passed 5 grains of solid chloride over oxide of Zinc in a green glass tube—obtained 69 parts of gas of which 18.5 were carbonic oxide and 50.5 carbonic acid; 35.4 of these parts = 1 c: i.; hence there were .5226 c: i: carb. ox. and 1.4265 carbonic acid, being 1.95 on the whole = .25 gr. carbon.

This not so much as with the per oxide of copper. The gas came over very cloudy and appeared to bring some of the fluid chloride with it. See how much chlorine the Zinc gives. It gave 11.2 chloride Silver = 2.77 chlorine. The decomposition very incomplete and the chlorine in excess; probably a portion of proto chloride has been formed which will account for it and indeed must have been the case from the circumstances.

OCTR. 30TH, 1820.

Reheat the fixed part of the fluid chloride and then see if it becomes as volatile as the other part.

HEATING.

Expose both fixed and volatile parts to spontaneous evaporation on glass and see what solid chloride is left.

HEATING. Lower the temperature of both portions and try to crystallise or freeze them.

Get Spec. Gravity.

Send the solid chloride over oxide of Copper in an Iron tube for the Carbonic acid gas and receive over Mercury.

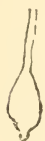
Do the same in a good length of green glass tube.

Expose both fixed and volatile fluids in chlorine.

May perhaps get the chlorine accurately by passing the substance over a good length of heated Zinc in a green or white glass tube, or over Iron in those tubes.

Or perhaps in Metal tubes with Zinc.

PROTO CHLORIDE
OF CARBON.



Took the S. G. of some of the distilled Chloride of the 26th. The little glass vessel I made with its corks stand weighed 7.3 gr.; filled up to a mark with the chloride it weighed 10.25 gr. and filled up to the same mark with water it weighed 9.2 gr. The chloride therefore 2.95 and the water 1.9—this gives 1.55263 for the S. G. of the fluid chloride.

This fluid chloride which I take to be pure was very volatile, and when heated at the bottom of water was converted into vapour when the water rose to between 160° and 170° F. It remained unacted upon beneath it and sol. of sul. silver scarcely affected the water; the effect which did take place probably from chlorine dissolved. It evaporated rapidly in a glass dish and left no traces of solid chloride behind nor of any thing else. It was not combustible except when heated by being held in the flame, and then burnt with a bright yellow light, much smoke and Acid fumes.

Its refractive power is very high apparently; two small tubes being filled one with water and one with the substance, then both immersed in water and a piece of printed paper lying at the bottom looked at through them, the water tube made the letters look smaller but the chloride tube made them look much larger. Enquire best means of ascertaining refractive power. The fluid does not freeze at the 0° of Faht.

OCTR. 31ST.

PERCHLORIDE
CARBON.

Passed 5 grains of the solid perchloride over per oxide of copper in a green glass tube: 2.65 c: i: of gas were recvd. over

hot water; of this $\frac{1}{37}$ was carbonic oxide and the rest carbonic acid; these = $\cdot 34$ of a grain of carbon. Now see how much chlorine in the copper; gave 17.7 chloride of silver = 4.36 chlorine + a little of the substance passed undecomposed.

PERCHLORIDE
CARBON.

NOVR. 1ST, 1820.

Endeavoured to send 5 gr. of the perchloride over Zinc in glass tube but the Zinc and also its chloride are too volatile and the glass tube swelled and blew out. The tube examined contained plenty of chloride of Zinc and charcoal.

Examined the two portions of fluid that had been separated by slow distillation. The part that had passed over when evaporated spontaneously left no solid chloride. The other part, evaporated spontaneously, left a little solid chloride; at least it answered in all points when tested by sublimation, combustion, Alcohol, water, etc. and the part which rose seemed readily volatile. Must distil it again by warm air.

PROTO CHLORIDE
CARBON.

Passed 8 gr. of the perchloride over peroxide of copper in a brazed Iron tube and received gas over Mercury. 4 c:i: of carbonic acid gas came over, but the tube gave way before the experiment was finished and from the fumes in the receiver it was evident a portion passed undecomposed.

PERCHLORIDE OF
CARBON.

Then Passed 5 gr. through another Iron tube with per oxide of copper; this tube stood the fire and 3.9 c:i: of gas were received over mercury. Barom. 29.85. Therm. 54°. Very good expt.

NOV. 2, 1820.

5 Gr. distilled slowly in a green glass tube and the gas received in sol. of nit. of silver, also the tube washed out with it and the fluid redistilled into it, gave by the most careful Management 4.3 gr. chloride of silver = 1.06 chlorine—too little chlorine—but some of the perchloride had escaped decomposition and condensed in crystals in the tube.

NOV. 3RD.

Went to Dr. Wollaston and ascertained the refractive power of the fluid chloride—it was 1.4875, water being 1.336. The per chloride has a very high refractive power, being above 1.5767.

PROTOCHLORIDE
CARBON.

PERCHLORIDE OF
CARBON.

Heated some of the perchloride with carb. of Ammonia. Mur. of Ammonia formed and a smell perceived something like cyanogen—but perhaps only proto chloride formed.

Put some of the sublimed perchloride with hydrogen into sun light in a dry retort and left for the present.

See Decr. 20th.

NOV. 13TH.

Perchloride sunk in Oil Vitriol of S. G. 1.85. Is by weighing in water as nearly as possible 2.

WITH EARTHS AND
OXIDES.

Heated with Protoxide of lead it gives chloride of lead and Carbonic oxide and acid.

Do. with Zinc.

With potash uncertain; water interferes.

Heated with lime, the lime burns brilliantly, charcoal is deposited, Carbonic acid formed and absorbed and chloride of lime produced.

The same with barytes, the combustion as brilliant as phosphorus in oxygen—no gas liberated, no Carb. oxide formed.

Do. with Strontites.

Not with Magnesia; only chlorine and proto chloride produced.

Did not make protoxide of Zinc burn.

HEIGHT OF CLOUDS.

There was a fire on Thursday Eveng. in Broad court, Drury Lane. The clouds were low and recvd. a strong illumination from the fire beneath them. The angle taken from the top of the R. Institution by a quadrant formed by the clouds, the institution and the fire, was 24° . Hence the height of the clouds will be = .

PERCHLORIDE OF
CARBON AND
HYDROGEN.

Hydrogen and the perchloride passed through a red hot tube—some solid chloride passed unaltered—fluid chloride passed coloured brownish—M. A. Gas was evolved and the rock crystal and tube were blackened by deposition of charcoal. Hence though the principal action was the conversion of the per into proto chloride, yet part of the latter seems to have been decomposed by the hydrogen.

PROTOCHLORIDE
OF CARBON.

Proto chloride—soluble in Alcohol—solution burns with a greenish flame and evolves fumes of Muriatic acid.

Sol. in Ether (very)—also evolves fumes on burning.

Sol. in Volatile Oils—they burn with fumes of Mur. Acid.

Sol. in fixed oils; but heat does not seem to char the solution and evolve acid as sols. of the perchloride do. PROTO CHLORIDE OF CARBON.

It is not soluble in N., M. or Sul. acids nor do any of them act on it at common temperatures.

It is not soluble in sol. of the Alkalies—nor do they exert any action at common temperature. Ammonia after standing 12 hours on it does not contain any chlorine.

Put into solutions of the hydriodates it does not act on them.

In hydriodic acid. Query.

Heated Chloride of Silver and S. A. in a flask—decomposition and liberation of M. A. G. Afterwards wash off excess of S. A. and got sol. of Sul. Silver. CHLORIDE OF SILVER AND SUL. ACID.

Sul. Silver may be fused at a red heat without decomposition—hence easy to convert chloride into sulphate of silver.

NOVR. 14TH.

Three retorts Numbered 1, 2 and 6. Some of the fluid chloride put with chlorine into retort 2, it being dry. PROTO CHLORIDE CARBON, ETC. ETC.

Some of proto chloride with Amm. Gas into No. 1.

Some of the proto chloride with Sul. Hydrogen gas into No. 6. No immediate action in any of them.

No action between the proto chloride and aqueous solution of Sul. Hydrogen.

An Alcoholic solution of Sul. Hydrogen made and some of the proto chloride dropped into and dissolved in it; also after a little while put in a drop of Ammonia, heated a little to drive off Sul. Hy., Amm., etc. and then tested by N. of Silver. There was chloride of silver formed. Hence M. A. produced and probably Sulphuret of Carbon.

To pass Substance and Sul. Hydrogen through hot tube.

Passed 5 gr. perchloride over quick lime—some passed undecomposed from strong ignition causing a little explosion—obtained 17 gr. chloride of silver afterwards = 4.2 chlorine. PERCHLORIDE CARBON.

Pretty good, but repeat.

NOVR. 16TH.

Retort No. 2 of Novr. 14th has been exposed to sun light yesterday and to-day. Now abundant crystals and fluid nearly PROTOCHLORIDE AND CHLORINE.

PROTOCHLORIDE
AND CHLORINE.

gone. The crystals were some dendritic and some square plates and in the microscope some rhomboidal. The retort placed over air full 1.5 inches entered, hence absorption of chlorine and formation of perchloride—then the air within retort examined—there was no Mur. Acid—the substance sublimed—was sol. in alcohol and precipitated by water—it had the smell, etc. and was the solid chloride. I can't help thinking the rhomboidal crystals were a deuto chloride of carbon = $\frac{\boxed{\frac{cl}{cl}}}{ca}$. Ascertain this.

AND SUL.
HYDROGEN.

The Retort No. 6 of the 14th has been there 2 days in pretty good sun light, but there has not been the slightest action. No change in the fluid, no absorption. No M. A. formed.

COOLED.

The proto chloride cooled to 0° of Faht. No crystallisation or solidification—the thermometer indicated 10°—but the cold was produced by pounded ice and Salt.

AND AMMONIA.

The retort No. 1 with Ammoniacal gas and protochloride has also been exposed 2 days to sun light (perhaps 5 hours per day), but not the slightest action of any kind.

PROTO CHLORIDE
AND EARTHS.

2.7 gr. of the pure proto chloride passed over red hot barytes—brilliant combustion with flame and very little charcoal deposited—when cold the whole of the barytes dissolved in diluted nitric acid, filtered and precipitated by nitrate of Silver gave 9.4 gr. dry, of chloride of silver = 2.32 gr. chlorine; should be 2.307. *Very good expt.*

1.6 gr. of do. passed over red hot lime—lime not quite dry—combustion not so bright and much charcoal deposited; a little passed undecomposed. This dissolved in N. A., etc. gave 5.2 gr. of chloride of silver = 1.28 gr. of chlorine. This gives 4 chlor. + 1 carbon by weight; too little chlorine; 5.55 of chloride silver would have been right.

I fancy a little of the barytes was peroxide and hence the small quantity of carbon deposited. I had been making peroxide of barium in the day.

PROTOCHLORIDE
AND PHOSPHORUS.

Some of the protochloride and phosphorus heated in a small tube. It dissolves a little phosphorus and when the solution is exposed to the air on paper the phosphorus generally inflames as the chloride evaporates. There appears to be no action on the chloride at a heat which boils it, for water afterwards poured

into the tube to wash out all soluble, being saturated with pure ammon. and evaporated to dryness with a little nitrate of barytes and heated, left nothing which being washed with water gave a precipitate of chloride of silver. Hence no M. A. formed by the heating of the two bodies at this temp.

The proto chloride dissolves sulphur and the hot solution crystallises on cooling. There is no decomposition effected at the boiling heat.

It does not lower the thermometer more than 6° by evaporation from it. From 60° to 54° .

1820. NOVR. 17TH.

Put a little proto chloride and sub. carb. of ammon. into a tube and heated the bottom red hot. There was decomposition of the substance, charcoal was deposited, Muriatic acid formed and probably nitrogen liberated. Hence ammonia at high heats decomposes *the chlorides*.

The proto chloride in vapour mixed over mercury with hydrogen and raised to about 300° F. An Electric spark passed through did not cause its detonation but many gradually decomposed the chloride and formed M. A.

The protochloride treated in a similar way with oxygen; no action took place.

Treated in a similar way with a mixture of oxygen and hydrogen the first spark caused a detonation with a bright flame in the tube; the gases were much expanded in volume and were M. A. and Carbonic oxide and acid.

Repeat and ascertain proportions.

1820. NOVR. 20TH.

Made a mixture of equal vols. of Oxygen and Hydrogen over mercury and detonated 1 vol. of this mixture with some of the vapour of the substance by electric spark over mercury. Inflammation bright, vol. of gases nearly doubled and a little charcoal deposited apparently by the action of the mercury on the chloride of carbon at the high temperature produced. A little water put in absorbed as nearly as possible half the gas produced or 1 vol., which was mur. acid, and the other half when examined

PROTOCHLORIDE
AND PHOSPHORUS.

AND AMMON.

AND HYDROGEN.

AND OXYGEN.

AND OXY. AND
HYDROGEN.

PROTOCHLORIDE
WITH OXY.
AND HY.

PROTOCHLORIDE contained no oxygen or carbonic acid but was pure carbonic
WITH OXY. acid.¹ It appears the mercury with the oxygen had assisted in
AND HY. decomposing the substance, so as to form carbonic oxide instead
of carbonic acid.

Good Expt.

Detonate with vapour of water.

It will not detonate with vapour of water.

Made a mixture of 2 vol. hydrogen 1 vol. oxygen, put in 3 vols. with some fluid into det. tube, vapourized and detonated. Apparently vapour of water rose from the mercury—would not detonate at first from excess of vapour—at last detonated when nearly cold. When quite cold the vol. of gas rather more than 3; on admitting a little water very little absorption, bringing it to rather less than 3. These 3 inflammable with a light blue flame paler than carb. oxide. After detonation no carbon deposited. Plenty of Mur. acid in the water passed up. It seems that the detonation had given rise to Water, Carb. oxide, Carb. acid, mur. acid and little free hydrogen. The Mur. acid had been absorbed by the water previously in the tube. Repeat expt. in New tubes.

1820. NOV. 21.

Made a mixture of 1 vol. oxygen and 2 vols. hydrogen; detonated 3 vols. of it with the vapour of the proto chloride by the electric spark over mercury. When cold the expansion was nearly to 6 vols. Then a very small quantity of water let in absorbed nearly 4 vols. of Muriatic acid gas and 2 vols. were found to be carbonic oxide. A very small residuum was left, being common air introduced with the tube containing the proto chloride.

Detonated 5.0 parts of a similar mixture in the same way with more of the protochloride. The expansion was to 9.75 and the absorbt. of Mur. acid gas by water equalled 6.25, leaving 3.5 which were carbonic oxide with a very small portion of common air introduced as before by the tube. The Inflammation in both these cases was bright but no carbon was deposited nor did the mercury seem to have acted.

Good expts.

¹ ? oxide

Passed 3 gr. of the proto chloride over per oxide of copper heated red in an iron tube: obtained 3.6 c: i: of carbonic acid gas, mixed with a little common air equal to .1 of a cub. inch; a little of the substance passed undecomposed in fumes. The copper taken out, dissolved in N. A. and precipitated gave 6.5 gr. of chloride of Silver, but it was difficult to collect all from the tube. The 3.5 c: i: = .449 gr. of carbon; should be .436 or 3.4 c: i: nearly.

PROTOCHLORIDE
AND OXIDE OF
COPPER.

NOV. 22ND, 1820.

Hydrogen and the vapour of the protochloride substance passed through a red hot glass tube—there was complete decomposition. Inflammation took place in the tube and the substances burnt together as they reached the hot part of the tube in a regular flame. Charcoal was deposited and Mur. acid gas in abundance liberated.

AND HYDROGEN.

Made a mixture of 3 vols. hydrogen and 1 vol. oxygen—detonated 4 vols. of it with the solid chloride in vapour over mercury—the expansion was to 6 vols., water took up 4 vols. which were Mur. acid; the 2 remaining burnt with a bright flame as if carburetted hydrogen were there. No carbonic acid was formed but water seems to have been formed.

PERCHLORIDE
CARBON WITH OX.
AND HY.

In another experiment of the same kind hydrogen appeared to remain behind and some carbonic acid was formed. These results too irregular to be useful.

Made a mixture of 3 vols. hydrogen and 2 oxygen; this should give M. Acid and Carbonic acid—but on detonation gave all sorts of results—M. A. Gas, Calomel, Carbonic oxide and a little carbonic acid were produced and perhaps water. Affinities very nearly balanced amongst these substances.

Results useless.

DEC. 20TH.

The retort with perchloride in Hydrogen has been in light until now, but there has been no action. Very fine crystals of perchloride have formed by slow sublimation.

PERCHLORIDE AND
HY.

See Novr. 11th.

SUL. ACID FROZEN. Froze some S. A. of S. G. about 1.78: the crystals were large but irregular and appeared to be oblique octoedrons. When mixed with ice they became fluid with moderate rapidity, but produced very little heat.

JANU. 2.

CHLORINE FROZEN. Put a moist bottle of chlorine into the yard. When the chlorine had frozen the crystals were in very delicate long spiculæ stretching out into the centre of the bottle from the side and some of them 2 inches long. They appeared equally thick in their whole length. A little frozen chlorine put into cold water did not seem readily soluble in it.

1821. JANU. 3.

PHOSPHATE OF LIME. When the insoluble phosphate of lime is put into nitric acid and dissolved and then precipitated by oxalate of Ammonia much oxalate of lime falls; the solution when filtered, evaporated, heated red, etc. is still a phosphate of lime which when once fused is neutral and insoluble in water.

1820. MAY 23.

CHLORINE AND CARBONIC ACID: ALSO WITH NITROUS OXIDE, MUR. AMM. AND SULPHUR. Chlorine and Carb. acid in sun light for 12 hours: no action. Chlorine and Nitrous oxide in sun light for 12 hours: no action. Mur. Amm. and sulphur distilled together; both rose together but sulphur most readily—no action.

1821. JANU. 24TH.

JULIN'S SUBSTANCE. *Substance from M. Julin.* Sublimed it through lime and then dried it by Leslie's process. It liberated a little ammonia but had no further action, and when thus pure did not act on the lime.

When heated red hot in green glass tube it was partially decomposed, depositing charcoal and becoming coloured, but this took place with difficulty.

A portion of it was heated over mercury with oxygen and detonated, depositing charcoal and producing expansion of volume. By lime water a little carbonic acid seemed formed but the result was principally carbonic oxide. The inflammation was very bright

(it burns with a bright flame in the air). It fuses when heated and then volatilizes, condensing in fine prismatic needles. It is sol. in spirit of wine and is thrown down by water. JULIN'S SUBSTANCE.

A portion was heated in chlorine to redness but appeared to suffer no change, subliming backward and forward through the heated (red) parts of the tube but always crystallizing as before. Yet still a gas seemed produced, for when the chlorine in the tube was absorbed by Mercury a gas remained which was not absorbable by mercury or water or alkalies and not combustible with either oxygen or hydrogen by the electric spark. Doubtful whether common air had in any way got in.

Of this gas 2.5 vols.

	+	3.5	oxygen	
		<u>6</u>		did not detonate by spark
added		4	hydrogen	
		<u>10</u>		they diminished to 3.5
			added	<u>2.1</u> hydrogen
				5.6

These diminished to 2.7

added 3.8 hydrogen
6.5, but no diminution or action by the electric spark. I think it must be nitrogen only.

1821. MARCH 5TH.

Put some artificial tannin into chlorine and placed them in day light and sun light: were left there. ARTIFICIAL TANNIN IN CHLORINE.

Put some iodine in Olefant gas and placed them in day and sun light: were left. See Octr. 22. HYDRO CARB. OF IODINE.

1821. MARCH 14TH.

Prints of Mr. Solly's plate.

BANK NOTES.

Number them 1, 2, 3, 4.

No. 1 was sized and left to dry.

No. 2 was sized and in about 10 minutes dipped into a weak infusion of bark.

No. 3 was sized and in 10' dipped into a stronger infusion of bark.

BANK NOTES. No. 4 was sized, left to dry and then dipped in chlorine in solution. Nos. 2 and 3 were considerably coloured by the infusion. No. 5 dipped into a borax infusion of Shell lac and when dry into very weak mur. acid. No. 6 dipped into a borax infusion of shell lac and left to dry. The colour of these two of a pale sienna tint and I think agreeable.

1821. MARCH 20TH.

CHARCOAL AND CHLORINE. Put some Lamp black that had previously been heated red into a retort, filled the retort with chlorine, drew out the neck at the blow pipe and sealed it hermetically. Placed on the house top and left there for solar influence. See April 4th, 1822.

ETHER AND CHLORINE. 25th. Introduced some Ether with chlorine into a dry retort. Much chlorine absorb[ed] and ether became bright yellow colour. Colour disappeared—introduced a little water—much mur. acid gas condensed—let in more chlorine—repeated the introduction of chlorine and left it for a day or two.

29th. Put a little ether into a large dry retort with chlorine and had introduced more chlorine into the retort above; was proceeding with them to the house top and had just got out at the door into bright *cloud* light when inflammation took place in both retorts. The larger one was burst into atoms; mur. acid gas and charcoal were evolved. The smaller (25th) did not burst but became black from charcoal.

March 30th. Put a little ether into a large retort and filled it with chlorine. This done by candle light: a little absorption at first, then left it all night in a dark place. On April 1 examined it; there was very slight expansion of volume. The colour of the chlorine considerably diminished and the substance inside thick and apparently adhesive. Exposed to sun light no further change took place. A little water let in absorbed 26.5 c: i: of mur. acid gas and produced a milky appearance in the retort. The retort was filled with water to remove gas, acid, etc.; an insoluble adhesive substance remained on the glass. The water was poured off and alcohol introduced; it immediately dissolved the substance. The solution tasted piquant, precipitated with water white and very much resembled the substance from Naptha (1820, Oct. 23).

Evaporated to dryness got a small quantity of a gummy substance still resembling the other.

ETHER AND
CHLORINE.

April 5th. Clean Tamarind stones—distilled at dull red heat—much tar, etc. given off—introduced some solid caustic potassa into the products and much ammonia produced—distilled the whole and obtained a very strong clear solution of ammonia. Query the nature of the tamarind plants and the quantity of nitrogen the stones contain. Query also the state of combination.

AMMONIA IN
TAMARIND STONES.

1821. APRIL 6TH.

Phœnecian coin analysed—is composed of Copper + Silver. It was a small cast coin weighing about 120 grains, having a rough white surface but brittle coppery fracture. It contained no lead, tin or antimony. The design was bold and well preserved and consisted apparently of characters or symbolic marks. A whole bag of these coins were found at _____ and were bought for £ .

ANCIENT COIN.

April 16. Some ether has been repeatedly acted on by chlorine and with water in the retort—a substance is left below the acid water which is fluid but will not mix—it is not at all volatile so that the water has been dried off from it—it burns with fumes of M. A., is soluble in Alcohol, precipitated by water—smell like camphor rather and resembles the former substances procured.

ETHER AND
CHLORINE.

April 16. Alcohol absorbs a little Sul. Hy. but does not alter it; the Alcohol retains a peculiar odour, like garlic, when the S. Hy. is driven off, but does not precipitate metallic solutions.

SUL. HY. IN
ALCOHOL.

April 18th. Ossified artery from a Man's Leg. The ossifying matter phosphate of lime—for Walford.

OSSIFIED ARTERY.

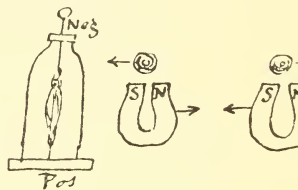
May 21. At the London Institution: Sir H. Davy's expts. Present Dr. Ure, Mr. Pepys, Mr. Vernon, etc. etc. with self.

Arc of voltaic flame in exhausted receiver; 2000 pair of plates, length of arc about 2.5 inches.

ELECTRO-
MAGNETISM.
VOLTAIC FLAME.

Horse shoe magnet (strong) approached to the side of the arc; the arc and magnet moved in contrary directions but the course of the arc was curved thus  and thus .

When the magnet was turned round then the arc followed its





motions, or in the contrary direction, both moving to the right or left together; * before it was thus.†

Expt. with a brush of common electricity the same.

1821. JUNE 1ST.

JULIN'S
CHLORIDE OF
CARBON.

Julin's substance. Having obtained more of it a portion was passed over heated quick lime; the lime blackened much, no combustible gas came over and much of the substance disappeared; a small portion however passed through and condensed in the tube. Ammonia also appeared.

Finding this a losing process, some crystals which appeared to be very pure were boiled for some time in caustic soda in solution, then filtered out, well washed and dried. They then appeared to be pure.

3 grains were then passed over per oxide of copper in a green glass tube. 5.7 cubic inches of gas were received over mercury, nearly the whole of which were condensed by caustic soda—a very minute portion of the substance had passed unaltered. Part of the copper (an inappreciable) was reduced, but a crystalline body appeared here and there in the tube which when examined proved to be chloride of copper. This and the oxide was dissolved in N. A. and the whole precipitated by Nit. of Silver. 6.1 gr. of chloride of silver were obtained but much had been lost in testing, etc.

Hence it is probably a chloride of carbon: to prove that it contained no loose chlorine a portion was dissolved in Alcohol and Nit. of silver added; there was no precipitation.

A portion was boiled some time in water and the water tested by N. of Silver, but no precipitation took place; hence no mixed Muriates as of Ammonia.

A portion was passed over red hot rock crystal in a green glass tube. The crystal became covered with charcoal and the gas received into sol. of nit. of Silver precipitated chloride of silver.

This was repeated with the small portion of substance that had been passed through hot quick lime and the same results produced.

A third time repeated the results were the same.

Query the formation of fluid chloride.

To pass a gm. weight of it over pure quick lime and get chlorine: also ascertain the absence of ammonia.

To detonate it with mixed oxygen and hydrogen.

To expose it to sun light in chlorine.

To act on light hydro carb. by chlorine in sun light.

To detonate by oxygen alone.

The non alteration of volume by detonation with oxygen formerly was occasioned by the absorption of the chlorine by the mercury. The experiments prove the absence of oxygen in excess above hydrogen and strength[en] the idea of the body being a binary compound.

JULIN'S
CHLORIDE OF
CARBON.

JUNE 5TH.

Little tube and substance 8.3 gr.—substance alone 2 gr. These sublimed over quick lime at a red heat: there was ignition in the tube when the vapour touched the lime and much charcoal was deposited. The lime was then dissolved in pure nitric acid—there was a slight smell of sul. hydrogen from sulphur as impurity in the substance. This was driven off by heat and then the solution precipitated by nitrate of silver; it gave 5.9 grains of chloride of silver = 1.46 chlorine.

Much carbon was left in making the solution of lime; it weighed when dried in the air .45 of gr., but still retained a little water and contained a small portion of lime.

2 vols. of oxygen + 2 vols. of hydrogen were detonated over mercury (hot) with excess of the vapour of the substance—the inflammation was bright and the diminution to one volume—drops of a fluid like water appeared in the tube and a whiteness like action on the mercury. A little lime water let up absorbed nearly all the residue and precipitated carb. of lime; a little acetic acid being then added the solution became clear, and on testing by Nit. of silver, chloride of silver was deposited.

It is probable that the 2 vols. of hydrogen took 1 of the oxygen to form water and that the remaining oxygen acted with the mercury in decomposing a portion of the substance—thus carb. acid and chloride of mercury would be formed, and the latter

JULIN'S CHLORIDE OF CARBON. decomposed by the lime water would give the chloride of silver by precipitation.

Query does the lime water blacken the tube.

Does not a little sulphur remain in the substance and blacken the mercury?

JUNE 27TH.

Julin's substance. Heated with phosphorus in green glass tube over mercury: decomposition by the phosphorus, charcoal deposited, chloride of phosphorus formed. No Muriatic acid gas produced.

Heated in the same way with iron; immediate decomposition, charcoal deposited and protochloride of iron formed. The tube washed out gave green muriate of iron.

Heated with mercury alone slowly decomposed.

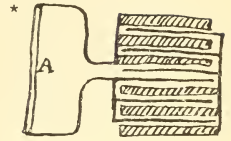
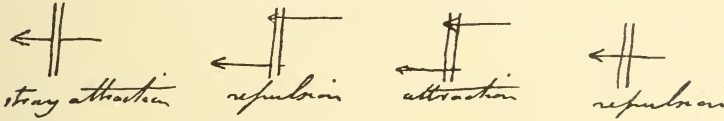
Mixed 2 Vols. of oxygen and 1 vol. of hydrogen; detonated 3 vols. of the mixture with excess of the vapour of the chloride over mercury. On applying the lamp so as to volatilise the substance the mixture inflamed within the tube without the electric spark, and burnt with a bright inflammation; the volume expanded to vols., which were a mixture of muriatic acid gas, carbonic acid gas and carbonic oxide gas. A very small quantity of lime water added caused the absorption of 2 vols. of the gas; on adding a farther quantity it remained transparent and it required more than the bulk of the whole gas before it became turbid from the formation of carbonate; at last became turbid and then the whole absorption of Mur. and Carbonic acid gas = vols., leaving vols. which were found to be carbonic oxide. On adding acetic acid to the solution till it became transparent and then testing, plenty of Muriate of lime was found.

SEPT. 3RD, 1821.

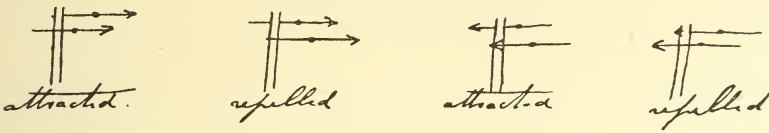
Electromagnetic expts. with Hare's Calorimotor. To be re-
membered that this is a single series?

ELECTRO-
MAGNETISM.

1. Position of the expt. wire A*.
2. Positions at first ascertained were as follows



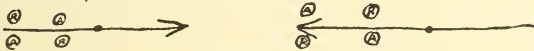
3. On examining these more minutely found that each pole had 4 positions, 2 of attraction and 2 of repulsion, thus



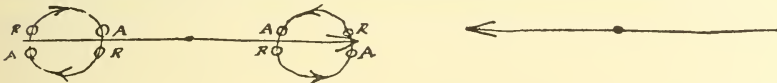
4. Or looking from above down on to sections of the wire



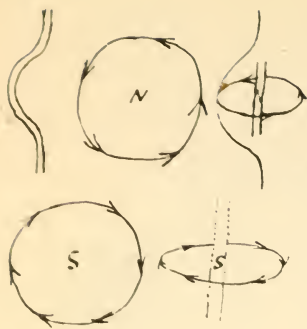
5. Or



6. These indicate motions in circles round each pole, thus



Hence the wire moves in opposite circles round each pole and/or the poles move in opposite circles round the wire. To establish the motion of the wire a connecting piece was placed upright in a cork on water; its lower end dipped into a little basin of mercury in the water and its upper entered into a little inverted silver cup containing a globule of mercury; the arrangement of battery poles always as at first. Magnets of different



power brought perpendicularly to this wire did not make it revolve as Dr. Wollaston expected, but thrust it from side to side. 8, 9. The wire then bent into a crank form, thus, and by repeated applications of the poles of the magnets the following motions were ascertained, looking from above down on the circle described by the bent part of the wire, different Magnetic poles shewn by letters, North pole in centre. The rod in the circle is merely put there to shew the front and back part.

10. Magnetic poles on the outside of the circle the wire described*.

11. The effort of the wire is always to pass off at a right angle from the pole, indeed to go in a circle round it; so when either pole was brought up to the wire perpendicular to it and to the radius of the circle it described, there was neither attraction nor repulsion, but the moment the pole varied in the slightest manner either in or out the wire moved one way or the other.

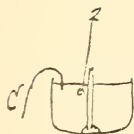
12. The poles of the magnet act on the bent wire in all positions and not in the direction only of any axis of the magnet, so that the current can hardly be cylindrical or arranged round the axis of a cylinder?

13. From the motion above a single magnet pole in the centre of one of the circles should make the wire continually turn round. Arranged a magnet needle in a glass tube with mercury about it and by a cork, water, etc. supported a connecting wire so that the upper end should go into the silver cup and its mercury and the lower move in the channel of mercury round the pole of the needle. The battery arranged with the wire as before. In this way got the revolution of the wire round the pole of the magnet. The direction was as follows, looking from above down [see diagram].

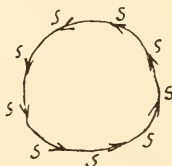
Very Satisfactory, but make more sensible apparatus.

TUESDAY, SEPT. 4.

14, 15†. Apparatus for revolution of wire and magnet. A deep basin with bit of wax at bottom and then filled with mercury, a Magnet stuck upright in wax so that pole just above the surface of mercury, then piece of wire floated by cork, at lower end



* [10]



† [14, 15]



dipping into mercury and above into silver cup as before, and confined by wire or capillary attraction from leaving the M. Pole.

ELECTRO-
MAGNETISM.

16*. Now Magnet round wire. The magnet had one pole so far sunk by platinum as to be low under the surface, leaving the other just above the surface whilst the whole floated; then the wire of connection was made to dip into the mercury near the pole.

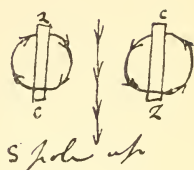
17. The Magnet Pole floating between the two wires in the mercury proceeds one way or the other in a right line between them; or the other way if north pole up.

18. But when the two wires are from the same pole the magnet is unacted upon between them.

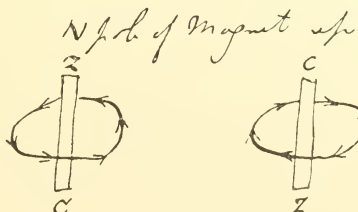
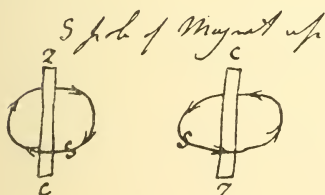
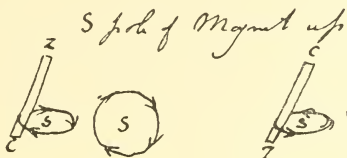
19. Could not make the Magnet or wire in the center turn round its own axis—but if the revolution depends on the motions of the currents essentially and not on the conductors except as the media, then perhaps those currents in the axis may turn without the media whilst those in the circumference cannot.

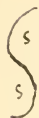
20. Every thing tends to prove that there is no attraction between the poles of the magnet and the wire, but only motion in a circular direction, and all the motions of the magnet or its poles about the wires may be deduced from this. When the single pole was floating upon the mercury it shewed it both by revolving round single wires and passing through double ones.

21. On floating a magnet horizontally on water at the bottom of which was mercury to connect the wires any where, the apparent attraction and repulsion of the poles were all reduced into the two circular motions about the wires. Hence also the reason why the magnet, when the connection is made, obeys both wires, taking a position exactly between them and with the poles as far as possible from the wire. It then goes to the nearest wire, but not by either pole but by its central point. And if the pole be put to the wire and slightly agitated the magnet will slip along the wire till midway across it.



* [16] N pole of Magnet up.



ELECTRO-
MAGNETISM.

22. Perhaps the settling of the needle perpendicular to the wire across it and then its approach on that side and its passing off on the other is the most instructive instance of attraction and repulsion. It is shewn that the attraction and repulsion, as they seem to be, are only the combined action of the two circles in which the poles endeavour to move round the wire, and two poles of different magnets, which alone merely tend to revolve round the wire in different directions, will, if tied together at a little distance from each other by a piece of thread, exhibit all the phenomena of attraction and repulsion that a complete magnet does.

23. The indifferent state of Mag. pole and absence of axis is shewn by the wire revolving in all directions about it.

24. The double curve, each part goes the same way with the same pole and different ways with different poles, make revolv. the same way though on opposite sides of the wire. This strengthens the idea that it is not the wires but the currents that revolve, and shew[s] that it is not this or that side of the wire that has any relation to the pole, but the position of the current to the pole itself.

25. A magnet made part of the circuit shewed no difference of property by other magnets or wires. Except that it took up filings only at the poles when unconnected but all over when connected, dropping part when connection broken. The two Magnetisms do not seem to interfere; nevertheless there must be some effect. Try weak magnet.

SEPT. 5TH, 1821.

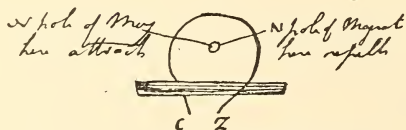
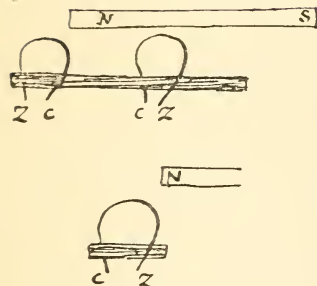
26*. Expts. with De la Rive's Curve. The shaded bars are merely to show the position of the curves.

If the Mag. pole be above the curve there are particular positions as follows:

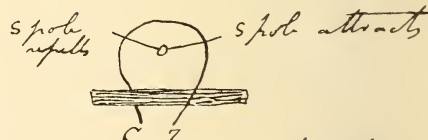
27. Rest in these positions, but if the part N be carried nearer to either of the curves they will move from it—the effect is for the curve to rise up and go over the N.

28. Here if N is exactly perpendicular to the plane of the curve it will attract it; if rather oblique to it it will turn the curve round and then repel it.

* [26]



N. pole of Mag. has attracts
N. pole of Magnet has repels
i.e. curve moves to left hand when N pole is centre



S pole repels
S pole attracts
i.e. curve moves to right hand when S pole is centre

29. Here the curve will move towards N if quite perpendicular to it (i.e. the plane); if oblique it will turn round and then be repelled from N a little this way [towards the right].

So that here all the effects are evidently owing to the effort made by the wire to revolve round the pole or the pole round the wire, and does not at all relate to the whole magnet, i.e. to both poles at once.

30, 31*. The curve placed in either of the dotted positions will take the central position and rest there. If the central position be reversed the curve will still rest there, but if ever so little on one or the other side of the centre it will pass that way from off the wire and be repelled, or if some slight cause make it oblique it will turn round and then go on, again taking up the position actually marked.

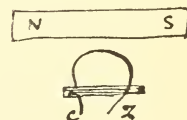
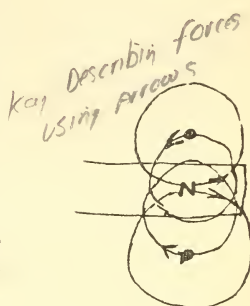
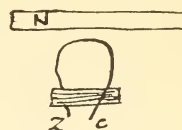
32. This an horizontal section of the magnet and curve, the two dots being the sides; the curves shew the way in which the wires and the pole endeavour to move and therefore the arrows heads represent the forces which are drawing the curve over the magnet or the magnet through the wire.

33. The tendency of a magnet or needle therefore is to go to the centre of the curve or helice, and a strong curve or helice ought to hold a needle just in its centre.

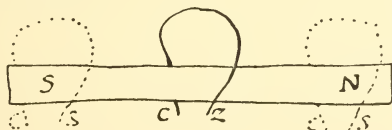
34. Magnet above the curve is the reverse of the Magnet through the curve.

35. Expts. to ascertain if Helice or curve would suspend a magnet. A magnet was corked so as just to sink in water. Then a helice constructed of Haberdasher's wire covered with cotton, round a glass tube, the curves being close; this connected and brought near the magnet in the water. The two mouths of the tube attracted and repelled the ends of the needle, and when attraction took place the needle entered quit[e] into the tube and took its place in the middle. If moved out at either end it returned again into the tube. But if when taken out it was turned round and then put into either end of the tube it was repelled or thrown

36. out at one or the other end according to its vicinity. Hence its natural state in the tube was with similar poles together, and its repulsive state with different poles together—the effect depends



* [30, 31]



ELECTRO-
MAGNETISM.

on its effort to carry the poles round the sides of the cylinder or helice as round the wire.

37. See if a natural cylindrical magnet will do this.

These are the same results as with De la Rive's curve and Magnet of Morning.

SEPT. 6TH.

Expts. on Direction of curve by the earth.

36.¹ Made a single combination and connected by copper wire in curve form; put this into a small jar with acid as a cell and put that jar on water to float. It very slowly arranged itself with curve perpendicular to the mag. meridian, and then a south pole attracted the inside of the curve towards the north. Repeated, same result. Curve about 4 inches in diameter, plate zinc about 4 square inches.

37.¹ De la Rive's little curve apparatus put into neck of a florence flask stopped and floated and with little acid; then on water just as upper. It very soon took direction perpendicular to Mag. Mer., and the side towards the N was attracted to south pole. It even oscillated about this position slowly.

38. Single curve helice of silked copper acted on a magnet just floating in water as might be expected from expts. of yesterday.

39. Silked copper wire—a close helice formed on a glass tube about half an inch diameter, the wire bell wire, and one end taken

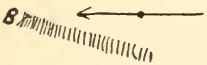
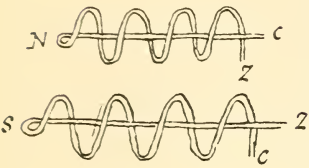
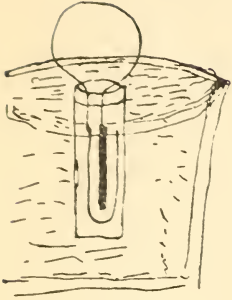
40. This acts at the external end on revolving wire, i.e. connecting wire exactly like magnet.

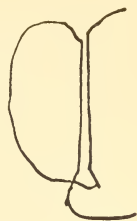
41. Its pole attracts and repels in 4 positions like magnet pole.

42. When its action on a needle is compared with that of the similar pole of a magnet it is perfectly similar except in one position, as in margin; in this it seems as if the helice repelled the needle, but in this way the Magnet attracts. The effect appears to be due to the separate state of the currents, which allows a little action in the opposite direction. This is shewn by effect of imitation of magnet by a plate bent: see farther on.

43. A double or two currents in different ways made of silked wire act just like a compressed helice: one crevice attracts but at the side repells; the other crevice repells but at the side attracts.

¹ In the MS. nos. 36 and 37 are repeated.





44. Two currents in same direction together act just as one does. Has 4 positions to the needle, etc. just as one current has.

45. Tried a long slip of copper, edges only active; it had the same effect as many currents (same) side by side, or rather as one broad flat current. Form of revolutions about it of course altered.

46. Another plate of copper, the middle bent nearly into a cylinder and then connected; was like the slip made into a cylinder, but long and narrow. This connected at two edges with mercury and battery the cylinder part acted just like a magnet and had two poles.

47. A square piece of copper connected at corners acted as a plate, but grew weaker from centre to side corner where the action was weakest.

48. The advantage of a helice consists in neutralising the central part between the poles and getting the poles separate. Hence in using strips of metal, the reason why edges only act because the circuits in the other parts are in the same direction and neutralise.

Is a single curve as strong as a helice?

SEPT. 7TH, 1821.

49. Attempted to make a straight wire direct by the earth, extending it from one basin of mercury to another, supporting its weight by water above and cork floats, but mercury foul and surface skinned so as to prevent motion.

50. Endeavoured also to make it rise and fall by position to the earth, as it actually did do to a north pole of a magnet to the north of it when the connection was made and broken; but could get no distinct effects.

51. Made a copper helice to repeat the expts. with the iron one of yesterday. Results were the same except that the magnetising power was so strong as quickly to change the polarity of the needle when reversed in the helice, and the repulsion soon became attraction.

52. Single curve not so strong as compound helice; the bands of metal act through each other and appear to concentrate in what has been called the pole.

53. A needle made to float with one pole up then brought under

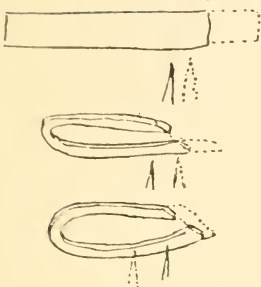
ELECTRO-
MAGNETISM.

the opposite pole of a magnet. It always pointed to a point in the axis not at the end but some little distance in from it, so that pole is not at the end.

54. The helice turned the same way agrees with the magnet except that the needle always points towards the end of the axis than to a part a little way up it; at least this is the case the needle being on the outside. Perhaps it is owing to the separate rings, to the tubular end and to want of solidity in the helice, which do not exist in the magnet.

SEPT. 8, 1821.

MAGNETISM.



Expts. on position of pole in Magnet.

Pole of needle floated, bar magnet brought over. Needle rested under the true pole. Piece of soft iron put to the magnet end, pole immediately moved towards the end.

One pole of horse shoe magnet brought over the needle: position of pole ascertained. Piece of iron put on, pole approached the end instantly. The iron made to connect both poles the needle, i.e. the poles, then moved the other way and became weaker.

On making the contacts better the effects all stronger, and if they had been perfect with the horse shoe magnet the polarity would probably have ceased altogether. Contact by other metals produces no effects of this kind; that¹ of course it is not the position in which it should be expected.

These expts. favour the current view, but they seem to shew that the difference between the helice and the magnet of yesterday (54) do not depend on the causes there mentioned, for I made a solid helice of small wire, but still the tendency to end quite as strong as before. It probably depends on the electromotive power within the magnet being by induction stronger in the middle part than elsewhere, and therefore the poles, being situated relatively to the whole power, will be within; the movement of the pole both in the single and horse shoe magnet favours this view. Query the best form for a magnet, i.e. so that the pole may be nearest the surface: an oblate or oblong spheroid or a sphere or a very thick ring?

¹ ? though.

A helice disk made, N. P. centre of one side, S. P. centre of the other—compare with steel plate similarly magnetised in centre. MAGNETISM.
Query opposite poles.

SEPT. 10, 1821.

2 Equal magnets (needle): 2 separate poles take up certain quantity of filings—2 similar poles together take up as much—2 different poles do not take up near so much.

2 similar poles, though they repel at most distances, attract at very small distance and adhere. Query why.

Large magnets, repelling poles attract at very small distances.

Flat spiral very active; attracts and repels same pole on different sides; takes up very much filings; strongest at centre. ELECTRO-MAGNETISM.

Do. not complete: to centre like former, but very beautiful with Iron filings.

Filings on paper over Helice arranged from one pole to the other in curves like as over magnet.

On Paper over spirals very beautiful indication of course of action.

Hollow Cylindrical Magnet would not draw needle through like the helice, but the pole of the needle always attracted by same pole of magnet.

Filings from bottom of hollow cylindrical magnet do not arrange as from hollow helice; they diverge both ways from the edge, but from the helice only outwards from the centre.

Could not magnetise a plate of steel so as to resemble flat spiral; either the magnetism would be very weak and irregular or there would be none at all.

OCTR. 22, 1821.

HYDRIODIDE OF
CARBON.

The Iodine and Olef. gas put in sunshine March 5th has been there ever since. Now examined—no iodide of carbon formed but simply hydrocarburet of iodine. A portion of this was analysed. 4 gr. were sublimed over heated copper turning and iodide of copper was formed with the evolution of pure olefiant gas. The quantity of gas amounted to 1.37 cubic inches. As 100 c: i: olef. gas weigh 30.15 gr.—1.37 c: i: will weigh .413 of gr.; $4 - .413 = 3.587$ iodine, and $3.587 : .413 :: 117.75 : 13.55$; nearly 2 proportions of Olef. gas, so that the compd. contains 1 proportion of Iodine 117.75 + 2 Olef. 13.4.

OCTR. 23.

IODIDE LEAD AND
CHLORIDE CARBON.

Fluid chloride of carbon distilled over red hot dry iodide of lead (which alone suffers no decomposition by heat, but now) iodine instantly liberated with strong action, chloride of lead formed and charcoal apparently deposited, for the tube became black.

Solid chloride of carbon over iodide of lead, nearly the same action. If any iodide of carbon formed in these cases the heat probably would decompose it.

IODIDE OF MER-
CURY, SULPHUR AND
PHOSPHORUS WITH
CHLORIDES CARBON.

Iodide of Mercury and perchloride of carbon mixed, put into a tube and iodide of M. over it; this heated considerably and then chloride of carbon sublimed through. It rose unchanged with little iodine from action of liberated chlorine, and iodide of mercury remained. No mutual decomposition will take place at heats below redness; if above redness results as above.

Alcoholic solutions of iodide of potassium and proto chloride and perchloride of carbon mixed: no change at all nor any decomposition.

Chloride of carbon distilled over hot iodide of phosphorus; the chloride seems to be decomposed but the carbon remains apparently uncombined. The results are various and confused but do not offer appearances of success. Experiment may be repeated with very dry iodine and phosphorus without any access of air.

Proto chloride of carbon passed over iodide of potassium heated; greater part passed unchanged—a little iodine set free—no apparent production of iodide of carbon. CHLO. CARBON + IODIDE POT.

Hydrocarburet of iodine over per oxide of lead, copper, etc.; iodides formed or else iodine liberated and the carbon and hydrogen liberated as oleft. gas or burnt by the oxygen of oxides. HYDRO CARB. IODINE.

Hydro carburet of iodine put into nitric acid became dark and nearly black after some little time without the liberation of any gas; being then examined it was found to be principally iodine with a little of the hydro carburet unchanged, so that the oleft. gas had been separated by the oxygen of the N. A. HYDROCARB. IODINE IN ACIDS.

Hydro carburet of iodine put into muriatic acid mixed with little chlorate of potassa; the bulk seemed to diminish slowly but the remainder was not changed in its nature.

OCTR. 26, 1821.

S. A. does not dissolve cold powdered charcoal.

CHARCOAL AND
SUL. ACID.

S. A. on cork: deep brown solution which, diluted with water, threw down a dark powder, apparently charcoal. It dissolves slowly again in strong sulphuric acid, forming a brown solution.

Chloride of silver and charcoal: no action when heated.

CHARCOAL, CHLO.
SILVER, MUR. AMM.

Chloride of silver and carburet of Iron heated: no action.

Mur. amm. over red hot charcoal: no action.

OCTR. 27, 1821.

Hy. carb. iodine in sol. of oxiodine in weak sunlight and by heat: no action. HY. CARB. IODINE.

Hy. carb. iodine in sol. chloriodine in weak sunlight—no action at first but by degrees the chlorine takes oleft. gas and forms the chloric ether, and the iodine liberated on both parts dissolves in it forming almost a black solution which, when it forms films, is of a fine crimson colour.

Olelt. oil and chloriodine in sol. in weak sun light: no action.

Therefore Hy. carb. iodine and chlorine would form Olelt. oil and iodine.

Dry chloride of copper, carbon and sulphur heated red: no.

CHLORIDES WITH
SULPH. AND
CARBON.

Cor. sub., charcoal and sulphur: no action.

Chloride Manganese, sulphur and carbon: no action.

Mur. Amm. over hot plumbago: very little action.

- PLUMBAGO IN CHLORINE. Plumbago in chlorine in sunshine—no action in two days—heated, slight action and chloride of iron formed with little water—action slow and probably from little mixture of oxide of Iron—nothing of importance occurred at the temperature of dull red hot.
- URIC ACID IN CHLORINE. Uric acid in chlorine in sunshine—no action in two days—heated, the acid became red as if purpurate of ammonia were formed—afterwards it charred, Mur. acid and water were formed and charcoal and nitrogen left—could find no particular result.

NOV R. 13, 1821.

- DYER'S SPIRIT. Dyer's Spirit analysed for Mr. Parkes.
A Sulpho Muriate of tin—was yellow—very acid and of S. G. 1.2592 or 1.26.
- | | |
|---------------------|-----------------------------------|
| A cubical inch gave | 52.4 gr. sul. baryta = |
| ” ” ” | 222. gr. chloride of silver = |
| ” ” ” | 27.6 per oxide of tin = 21.53 tin |
| ” ” weighs | 318.4 grains. |

DEC R. 20.

- COOPER'S IODIC SUBSTANCE. Cooper's substance from iodine.
A fluid body containing crystals—solution of potassa takes away the deep colour and leaves the oil yellow and heavy. Its deep colour is owing to iodine dissolved. It decomposes slowly at common temperatures, becoming brown, and appears to be completely decomposed by a red heat. It is however evidently a mixture of two or more substances, for when cooled it deposits crystals, though the whole does not crystallise. Decomposed by being passed in vapour through a red hot green glass tube, 3.1 gr. gave .81 of a cub. inch of hydriodic gas unmixed with any other gas and iodine and carbon remained in the tube. When the tube was heated so as to drive off all the iodine, etc. and .2 of a grain of charcoal remained behind. It seemed however that all the substance had not been decomposed. There is evidently hydrogen, charcoal and iodine in the mixture. Query what else.

Made a piece of copper wire of this form, on a glass tube for axis so that the part *ab* about 12 inches long should balance the weight *c* so nearly that, when supported in glass basin of mercury by the points *d, e*, the whole should be in such equipoise that it would vibrate with a very small power. It was then placed with the glass rod perpendicular to the magnetic meridian, and wires from the poles of a battery connected with the mercury in the cups *d, e*; immediately this was done the wire *ab* moved; when *d* joined the zinc and *e* the copper plate of Hare's calorimotor the wire moved towards the north, and when *d* joined the copper and *e* the zinc plate the wire moved towards the south.

These motions are evidently the result of a rotative force emanating from the pole of the earth and acting on the wire; they account also for direction of Ampere's curve.

DEC. 22.

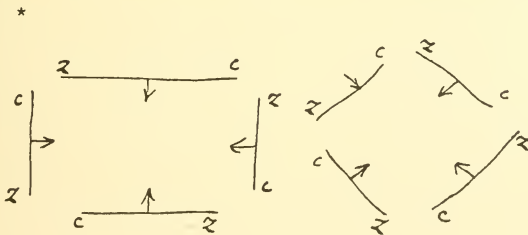
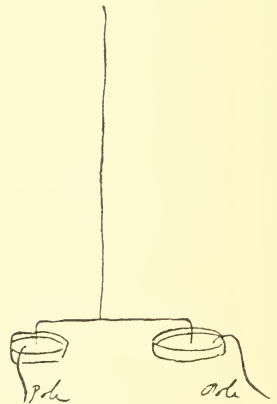
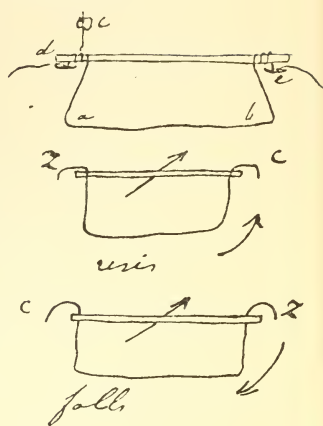
A copper wire hung by silk thread from the ceiling, ends amalgamated and dipping into two basins of mercury. Mercury cleaned and distilled over it in the basins, a little diluted pure nitric acid to dissolve the film and allow free motion. When the wires from Hare's calorimotor were put into these basins the wire immediately moved horizontally and laterally, so that the direction of the motion was perpendicular to the wire itself. On breaking the connection the wire returned to its first position.

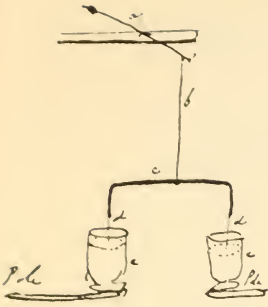
The extent of this motion was as much as 3 inches; its direction was as follows by the diagram*.

It is evidently the attempt of the wire to rotate round the pole of the earth.

This motion by theory should take place in a plane perpendicular to the dip of the needle in all latitudes. Hence towards the North at this lat. it should be a little ascending and towards the south a little descending.

Tried to ascertain the slight difference of weight that would then be caused by electrizing a wire. Arranged an apparatus

ELECTRO-
MAGNETISM.



thus—*a*: small steelyard, *b*: silk thread, *c*: bent copper bell wire, *d*: fine copper wire attached to the other wire and well amalgamated, *e*: two glass vessels containing clean mercury and little acid and having a communication beneath to two slips of lead with which to connect the battery wires.

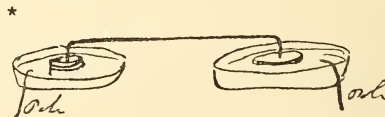
Now expected to find that on connecting the wires one way the wire *c* would rise and on connecting the other way *c* would fall; but found that which ever way the connections were made the wire *c* rose considerably, above $\frac{1}{4}$ of an inch.

Ascertained that it did not depend on any oblique action of the thread by the tendency of the wire to move laterally, nor upon any local action as from the conducting wire, nor on the action of the earth, for it took place in all azimuths and which ever way the wires were connected. Could not make out the cause at all.

DEC. 24.

Got to work again. In stead of suspending the wire for lateral motion from the ceiling put two discs of cork on and let it float on the mercury, with the acid on as before*. Motion again took place but sluggishly; too much friction by the corks on the mercury.

Experimented with the wire and steelyard, and on close examination found the surface of the mercury altered whilst the current passed from the wire into it, for every time the contact was made the little cone of mercury raised up round the small wire by the capillary attraction—or the attraction of cohesion—diminished and became less, and when the contact was destroyed resumed its original bulk. Hence a part of the attraction of the mercury for the wire is destroyed when electricity is passing from the one to the other, and consequently the wire rises. I took a short (1 inch) piece of small silvered copper wire and amalgamated it well, then soldering it to a thick piece of wire. I dipped the other end into clean mercury having a little diluted acid over it, and fixed it in that position. I then connected the mercury and the thick wire to the poles of the calorimotor and could readily see the effect produced on the cone of mercury. It was to the same extent which ever way the poles were connected. But a battery of 10 pair of Wollaston's plates 4 inches square

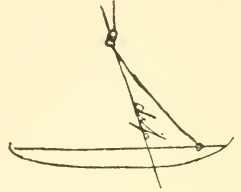


had no sensible effect in producing the alteration of surface. Hence great quantity is required. ELECTRO-
MAGNETISM.

Using thicker wires the effect very rapidly diminished; the thin wire was the $\frac{1}{56}$ of an inch in diameter.

1821. DECR. 25TH.

Rotation of a wire by the earth magnetism. In a large glass basin put mercury and a little dilute N. A. Took about 6 inches of wire $\frac{1}{56}$ of inch thick, amalgamated it, formed a hook at top by which it was suspended from another fixed hook as in tube apparatus, put a little bit of cork on the lower end, the wire passing through it, and then held it over and on the mercury so that the wire formed an angle greater than the dip of the needle. Then connecting the mercury with one pole and the wire with the other it began to rotate and continued rotating whilst the connection continued. On changing the connection the direction of the motion changed also.



DECR. 26, 1821.

COOPER'S IODIC
COMPOUND.

Cooper's solid substance—is yellow, fuses by heat, and at higher temperature is decomposed, giving apparently nothing but iodine and charcoal. The wet substance pressed and put over sul. acid in vacuo to dry.

Fluid substance—still impure—4.1 gr. of it passed over red hot oxide of copper. 1.8 c: i: of gas were evolved which were carb. acid. The apparatus had lost by its evolution .9 of gr. A little water had condensed in the tube: this driven off = .4 of gr.

A portion of it was inclosed in a tube exhausted of air and put to distill by warm air.

1822. APRIL.

AMM. + N. GAS.

= Vols. of Amm. and N. Gas, dried previously, had no action on each other at common temperatures, or at a dull red heat, or when exposed to solar light for 2 days; but a light put to the mixture inflamed it.

WAX IN
CHLORINE.

Wax put into chlorine and exposed to sun light for 2 or 3 months. Chlorine very slowly disappears and the [wax] becomes a soft body but little altered in appearance, but which when heated gives out muriatic acid and soon chars—it melts and sputters by heat.

APRIL 4.

LAMP BLACK IN
CHLORINE.

The lamp black (see March 20, 1821) not affected in the slightest degree—the chlorine as bright as ever—not opened but left for further influence of solar light. Opened May 10th—no change.

1822. APRIL 13.

N. GAS AND SUL.
HYDROGEN.

Made expts. on Nitrous gas and Sul. Hydrogen lately. These gases as usually prepared appear to act on each other readily but this is a mistake arising from impurities in them. When the sul. hydrogen contains a little air, as it almost always does, Nitrous acid gas is formed and then there is action on the sul. hydrogen, or when mixed over water containing air or perhaps over pure water there is action, but when quite pure and dry there is no immediate action on mixture.

Portions were mixed dry: some of them placed in the dark acted in several days, other in sun light much sooner, but the

results the same: 7.1 c: i: N. Gas and 7.1 c: i: sul. hydrogen, dry, mixed in retort and left in sun light 4 days, deposited crystals of sulphur; and then opened over water condensation took place, only 3.2 c: i: of gas being left. The formation of water could not be decided because the stop cock had permitted a little to pass in from the jar in which it stood; of the 3.2 c: i:, 2.3 were absorbed by water and from another experiment were known to be nitrous oxide, and .9 of c: i: was nitrogen, probably from impurities in the gases. There was no N. Gas or Sul. Hydrogen left.

N. GAS AND SUL.
HYDROGEN.

In other experiments the gases not dry but mixed in a damp jar over mercury. Action in the sun light and hydrosulphuret of ammonia formed; the ammonia liberated by lime and made evident even to smell.

The formation of ammonia in these cases is probably the cause of the want of relation in the Nitrous oxide left in former experiment.

1822. MAY 30.

Some Nitrous gas has been left over sol. of sub-carb. of potash for a month or more in sunshine. There has been a slow gradual diminution amounting now to about $\frac{1}{5}$; the rest of the gas proved to be nearly pure nitrous gas containing only a little nitrogen—so that the nitrous gas that has disappeared has probably been converted into Nitric acid slowly by the air dissolved by the solution—no decomposition of the remaining portion having taken place.

N. GAS AND SUB.
CARB. POTASH.

APRIL 22, 1822.

Album Græcum from Mr. Latimer [?], Kirkdale Caverns. No. 1. 1st. specimen. Boiled in water. Nothing but a very slight portion of animal matter.

ALBUM GRÆCUM,
KIRKDALE.

Heated, gave water—blackened—little ammonia—hence insoluble animal matter.

Pulverised—effervesced with M. A.—digested—solution contained lime and phos. lime—sand and flocculi (few) of animal matter left.

Tested for animal matter by N. A. and Amm.—some present. Hence Carb. lime—phosphate lime—triple phosphate—animal matter—water—sand.

ALBUM GRÆCUM, No. 2. Second specimen. Cellular as if organised. Heated—water
KIRKDALE. —plenty ammonia—blackened much—inflammable gas—black ash
—animal smell.

Mur. acid—carb. and phos. lime—flocculi of animal matter.

Trace of Sul. lime and Mur. soda—traces of animal matter by
N. A. and Amm.—on digestion by acid gave albuminous texture
of bone.

Contains Carb. lime—phos. lime—triple phosphate—more ani-
mal matter than last—water.

BONE. KIRKDALE. Piece of bone from Kirkdale—very hard and fresh—heated,
very much ammonia—blackened and burned into white ash—with
acid gave carb. and phosphate of lime—albuminous structure—no
common salt.

NIT. AMM. AND MANG. May 9th. Triple nit. of Manganese and ammonia evaporated
in a retort and when concentrated heated.

1822. MAY 10TH.

SEA WATER. Sea water—S. G. 1027·2.

Another specimen from the equinoctial line 1027·6. $\frac{1}{2}$ pint
S. G. 1027·2 = 3924 gr. nearly. This boiled away until Sul. lime
began to deposit now weighed 690 gr.—evaporated farther until
common salt just ready to crystallise when cold weighed 445 gr.—
evaporated till ready to crystallise when boiling weighed 430 gr.
—evaporated till Mur. acid given off weighed 139 gr. of salts,
but not quite dry.

1 cub. foot sea water S. G. 1027·2 = 1026·265 oz. avoird.

1822. MAY 29TH.

S. G. OF MERCURY Specific Gravity of Mercury at 40° F.

AT 40° F. Weight = bottle and 969·8 gr.

Weight + 1·4 = bottle and 971·2 gr.

Weight + 1·4 = bottle and water at 40° F.

Weight + 928 = bottle, 1000 gr. mercury and water at 40°.

928 + 969·8 = 1897·8 water and Mercury

= 1000 Mercury + 897·8 water.

Water at 40° F = 971·2 - 897·8 = 73·4 water displaced by 1000 gr.

Mercury at 40° F.

$\frac{1000}{73·4} = 13·62397$ or $13·624$ S. G. Mercury at 40° F.

Napthaline in Chlorine in retort—immediate action—heat evolved—whole became fluid—absorption in the retort and Mur. acid gas formed—on cooling crystals formed in the fluid and it seemed like a mixture of the crystals and a tenacious viscid fluid—evidently 2 distinct compounds formed—washed with ether which, though it dissolves both substances (as does Alcohol), dissolves the fluid in most abundance—got some of the crystals clean—were white, hard and brittle—when moderately heated, melted and cooled into a hard brittle mass capable of being scraped or rubbed into powder—heated more highly in the air apparently volatilised in acrid fumes, but in close vessel seemed not to rise without decomposition—suspect that in the air it rises forming some new compound; when burnt gives flame, smoke and Mur. acid gas—the fluid part resembles in appearance the substance from Naptha, etc. by chlorine. If keep substances cool whilst chlorine acts perhaps have no production of Mur. acid and more of solid compound formed, for when hot the substance seemed to boil from liberation of Mur. acid and by heat the solid substance becomes soft and even fluid just before decomposition.

NAPHTHALINE IN
CHLORINE.

JUNE 10TH, 1822.

Steam from a kettle—a thermometer placed in the current, sometimes with the salt merely placed on it and sometimes the bulb and salt tied up either in lint or flannel or wadding. The following are the results.

HEAT OF VAPOUR
AND SALTS.

Sub: carb: pot: alone	. . .	258°
” ” ” wadding	. . .	260°
” ” ” lint	. . .	260°
” ” ” flannel	. . .	262°
Common salt alone	} hardly above	212°
” ” and lint		
Lump sugar pounded alone	. . .	216°
” ” ” lint	. . .	223°
Nit. amm. lint—ammonia liberated	. . .	240°
” ” alone	. . .	236°
Acetate potash alone	. . .	244°
” ” flannel	. . .	258°

HEAT OF VAPOUR
AND SALTS.

Citric acid alone	230°
„ „ in flannel	228°
Tartaric acid alone	226°
„ „ in flannel	221°
Mur. Ammon. alone	230° very correct
„ „ in lint	227°
Nitre alone	232° convenient
„ in flannel	230°
Sul. Mag. alone	218°
„ „ in lint	214°
Nit. Mag. alone. . . .	236°
„ „ in lint	236°
Tartrate potassa alone	236° very convent.
„ „ in lint	220°
Potash in forceps Mounted up to	370°. At 300° and 310° would rise and fall as taken out and put into the stream again.

JUNE 11.

Boiling points of Saturated Solutions.

Sub carb. potash	284°
Mur. Amm. . . .	238°
Tartrate potassa	242°
Nit. Amm. . . .	254° and upwards?
Common Salt	228°
Nitre	240°

A boiler with some water in it, a thermometer in the water and another in the steam

	in vapour	in water
boil { at common pressure	212°	212°
{ increased pressure	220°	219° +

A solution of sub carb. potassa put into the boiler

	in vapour	in water
at common pressure	212°	217°
increased pressure	222°	227°
let down to common pressure		217°, but
the vapour thermometer dirty, so that stood at 214°.		

Steam at 212° sent into a glass containing sub carb. potassa—a thermometer introduced into the sol. formed stood at 240° . HEAT OF VAPOUR
AND SALTS.

Sent into sugar, temp. 224° .

Alcohol in a flask boiled at 182° ; vapour 182° . Bulb of thermometer with powdered Mur. lime wrapped up in lint and put in the vapour soon rose to 210° and would probably have risen higher.

JUNE 1822. 12.

Some eggs have been in saturated solution of common salt SALT EGGS.
now about 10 days—one boiled was nicely salted throughout.

JUNE 1822.

Diluted solution of Muriate of Zinc boiled and evaporated on zinc filings oxidises the metal and dissolves oxides. The diluted solution is acid to litmus—after the concentration has gone on some time it is still acid to litmus but it is also alkaline to turmeric—if diluted with water, oxide falls from it. When pretty strong it shakes frothy, feels saponaceous, dissolves paper and has a greasy feel when evaporated. When very strong and saturated a large quantity of oxide appears to be deposited on dilution. If the diluted be evaporated to dryness and heated a little Mur. acid is driven off. MURIATE OF ZINC.

A portion of most diluted precipitated by nitrate of silver gave 356 gr. chloride of silver = 88 chlorine and oxides zinc 101 = 82.3 zinc. Brande.

Chlorine . . .	88	34
Zinc . . .	82.3	31.8

A portion evaporated to dryness and heated red hot in a close tube was transparent and colourless—glassy fracture—a portion dissolved in weak N. A. gave 175.6 chlo. silver = 43.2 chlorine and 49 gr. oxide of zinc = 40 Zinc.

Chlorine . . .	43.2	34
Zinc . . .	40	31.48

very nearly alike.

MURIATE OF ZINC.

Water alone acts on zinc at 212° evolving hydrogen. Sol. Mur. lime acts on Do. with evolution of hydrogen abundant.

Chloride of zinc when precipitated by water seems to deposit a sub chloride.

JUNE 24.

APPARENT
ALKALINITY.

Effect of various salts with Turmeric paper.

Weak green Mur. Iron—very alkaline.

Weak per Mur. Iron—very alkaline indeed.

Tinct. Do.—very alkaline.

All the sol: salts of Iron—Green vitriol very marked indeed.

Acetate of Iron very little.

Chloride of Manganese very feeble but evident.

Nit. Manganese—No.

Sul. Do.—no.

Mur. Gold—uncertain.

Acid. nit. bismuth—alkaline.

„ „ diluted till oxide deposited—more alkaline.

Chloride of antimony precipitated by water—well.

Per mur. tin—well.

Proto Do.—pretty well.

Sulphate—little only.

Mur. zinc—alkaline.

Nit. zinc—yes—when strong better.

Sul. zinc—no.

With Rhubarb paper.

Per Mur. Nit. Sul. and Acetate Iron. Olive green tint.

Proto Mur. Iron; no change at first, green at edges gradually.

Proto sul. and Nit. Iron green the paper (per salt?).

Acid Nit. bismuth when dry by fire brown like Alk.

Nitric acid diluted quite alkaline and natural.

Strong sulphuric acid also.

Strong Mur. acid sol: very little.

Per and Prot. mur. tin } Little at first, quite brown when dried

Sul. tin } at fire.

Mur. zinc—very good and natural.

Nitrate of Uranium (neutral) appears considerably alkaline to APPARENT
Turmeric paper; $\frac{1}{600}$ of nitrate in solution affects paper. ALKALINITY.

Muriate of Uranium (neutral) appears very alkaline to turmeric paper even when very considerably diluted.

Sulphate of Uranium also alkaline.

Carbonate? Uranium dissolved in water by carbonic acid affects turmeric paper and makes it brown.

SEPT. 10TH.

Polarized a ray of lamp light by reflection and endeavoured to ascertain whether any depolarizing action exerted on it by water placed between the poles of a voltaic battery in a glass cistern—one Wollaston's trough used—the fluids decomposed were pure water—weak solution of sulphate of soda and strong sulphuric acid. None of them had any effect on the polarized light either when out of or in the voltaic circuit, so that no particular arrangement of particles could be ascertained in this way. DECOMPOSITION OF WATER BY ELECTRY.

1822. SEPT. 16TH.

Triple Mur. of Amm. and Platinum when decomposed by heat evolves water—muriatic acid—nitrogen—mur. of ammonia and leaves platinum—the chlorine of the chloride of platinum seems to act on the hydrogen belonging to the ammonia of the muriate and forming Mur. acid to liberate the nitrogen. MUR. AMM. AND PLAT.

If sulphur be mixed with the salt previously and the distillation then take place—Mur. amm.—water—muriatic acid—nitrogen—chloride of sulphur—sulphur—and sulphuret of platinum are the results. The sulphur carries over some sulphuret of platinum with it and is for the greater part of a fine green colour. Water does not dissolve any of the coloured matter, but Alcohol does and becomes of a fine green tint. It seems to me at present to be sulphur so far altered as to assume a green colour and to be more soluble in alcohol than common sulphur, but it may be a compound of that substance with some other body—a small portion of it collected and heated with mercury in close vessels did not evolve any permanent gas—when fused in close vessels it retains its green colour even in fusion, looking like a brilliant green varnish. SUL. AND MUR. AMM. PLAT. GREEN SULPHUR.

MUR. AMMONIA
AND CHLORATE
OF POTASH.

See Sept. 23.

About 2 parts of Mur. Ammonia + 1 part chlorate of potash—well mixed together and struck on an anvil detonate evolving a smell like euchlorine.

Muriate of Ammonia and chlorate of potash mixed, there being excess of chlorate—heated in a tube retort—rapid action at comparatively low temperature. *Results*: chloride of potassium—Mur. acid—Water—Euchlorine—Chlorine—oxygen—Nitrous oxide. The Mur. of Ammonia is decomposed, none remaining—the ammonia itself yields up its hydrogen and its nitrogen, both being oxidised—the Mur. acid liberated acts on the undecomposed chlorate of potassa and produces the euchlorine—chlorine, etc. etc.

A mixture made with excess of Mur. ammonia. *Results*: Chloride potassium—Mur. ammonia—Mur. acid—Euchlorine—chlorine considerable quantity—Nitrogen—nitrous oxide little only—Water.

The substances mixed with water and boiled: no action took place.

1822. SEPT. 21.

GREEN SULPHUR
OR SULPHURET
OF PLATINUM.

The green substance of sept. 16 is sulphur combined with a small portion of sulphuret of platinum. It burns with a blue flame tipped with dull red—it deposits a reddish brown coat on the glass or platinum foil on which it is burnt. It is more soluble in hot than in cold Alcohol and therefore a hot saturated solution deposits crystals of it. They are small and of an olive green colour and when fused become of a brilliant green tint. When sublimed in close vessels the sulphur rises and sulphuret of platinum in very small quantity is left. It is more soluble in oil of turpentine than in alcohol and more at a high than a low temperature. Heat however alters the solution; when made at common temperatures it is of a fine green colour but by heating becomes of a brown red tint. If hot oil of turpentine be used in the first instance in place of alcohol to dissolve it a deep red coloured solution is obtained.

If sulphur be fused with a little sulphuret of platinum a green substance is also procured, but not so bright as the former and giving little or no colour to alcohol.

Sulphur fused with the triple mur. of ammonia and platinum always gives it both in the sublimate and the residuum.

GREEN SULPHUR
OR SULPHURET
OF PLATINUM.

Sulphur, Mur. amm. and a small quantity of the triple muriate fused gave abundance that rose in green fumes; and the mass left, if not too much heated, also gave deep colour to alcohol; still however much uncoloured sulphur. The excess of mur. amm. was washed away by water before alcohol or oil of turpentine applied.

SEPT. 27, 1822.

Sulphur + Sulret. Platinum rubbed together and boiled in oil of turpentine—no platinum dissolved.

SEPT. 21, 1822.

A piece of metallic arsenic heated by blow pipe on wood or card will, if left by itself in the air, continue to fume till it has all disappeared. A kind of imperfect and low combustion goes on—white oxide is produced and forms a hill round the piece of metal and the fumes are of a dense brown—these condense readily into a powder, nearly black, which may either be an oxide of arsenic or a mixture of metallic and white arsenic or contain all three. In ammonia abundance of white arsenic dissolved—in water also, but metal does the same—sublimed in a close tube—forms much metal and about $\frac{1}{4}$ or $\frac{1}{3}$ white oxide.

SUB COMBUSTION
OF ARSENIC.

As the effect goes on the piece of metal has its surface beautifully dissected into crystalline forms.

SEPT. 23, 1822.

See Sept. 17th.

Chlorate of Potassa + Mur. acid sol. slightly heated. Water, chlorine and euchlorine liberated and if the acid be in sufficient quantity and the boiling continued no chlorate remains; all converted into Muriate. The oxygen of the chlorate even at this low temperature decomposes the Mur. acid and combines with both its elements.

CHLORATE OF
POTASH, MUR.
ACID AND MUR.
AMMONIA.

Chlorate of potassa + excess of Mur. Amm. There is no chlorate left (after heating), only chloride.

Chlorate potassa + Mur. Amm. + Mur. acid in small retort.

CHLORATE OF
POTASH, MUR.
ACID AND MUR.
AMMONIA.

Azotane formed and collected together on the top of the Mur. acid—much gas liberated on warming; it was a mixture of Euchlorine and nitrogen. When there was plenty of Mur. Amm. and Mur. acid with sufficient length of boiling no chlorate was left undecomposed.

2 prop. chlorate potassa	3 prop. Mur. Amm.
2 c = 72	3 c = 108
2 p = 80	3 n = 42
12 ox = 96	12 h = 12
24.8	16.2

Made a mixture as preceding page¹ of 25 gr. chlorate potassa and 16.2 gr. Mur. Ammonia—heated a portion in a tube—rapid action with pale inflammation—water formed. Nitrous gas—Mur. acid—chlorine and nitrogen—nearly all the chlorate decomposed.

Put a portion in a tube with Mur. Acid—heated. Euchlorine in abundance—chlorine and nitrogen. Of course water also.

124	54
1 prop. chlorate of Potash +	1 prop. Mur. Am.
1 p + 1 c + 6 ox	= 1 n + 1 c + 4 h
1 chlorate amm.	+ 1 mur. potash
n + 3 h	Water 1 c
c + 5 ox	1 ox + 1 h 1 p

SEPT. 25.

Made the mixture of 1 prop. of each as above and dissolved and boiled; still tasted of Mur. Amm. and on crystallisation still crystals of chlorate potassa—hence no mutual decomposition, at least to any extent.

Evaporated to dryness and well mixed—heated in a tube gave Chloride potassium—Nitrous gas—Nitrogen—Chlorine—Water—Mur. Amm. a little sublimed.

With Mur. acid boiled gave plenty of gas—euchlorine—chlorine—nitrogen—apparently more nitrogen than chlorine.

Mixture detonated by strong percussion.

CHLORATE
POTASSA + MUR.
AMMONIA + SUL-
PHUR, ETC.

Mixed with sulphur and heated in a tube—quick action—water—Sulphurane—nitrogen—Suls. acid gas?

¹ Immediately above.

Perchlorate of potash is not altered by M. Acid.

Chlorate of potash and M. Acid; no perchlorate formed, only chloride of potassium left.

CHLORATE
POTASSA + MUR.
AMMONIA + SUL-
PHUR, ETC.

SEPT. 26.

Mur. Amm. + chlo. potassa + Sulphur + Mur. Acid — no action on the sulphur—euchlorine—chlorine—nitrogen, etc. just as if without sulphur.

Chlorate potassa + sulphur + M. Acid—euchlorine—chlorine—just as if no sulphur present.

Mixture made of 1 prop. chlorate potassa = 124 and 1 prop. nitrate of ammonia (dried) = 71; took 80.

NIT. AMM.
+ CHLORATE OF
POTASSA, ETC.

Detonates by percussion.

Dried nit. amm. alone does not detonate by percussion.

Mixture dissolved and boiled—still taste the nit. of ammonia and on evaporation gave crystal of chlorate of potassa.

Heated a portion of the mixture in glass tubes and retorts. When action once commenced is very violent, and communicates itself to the other parts of the mass—results very complicated. Euchlorine—Nitrogen and oxygen in abundance in the proportions of about 9 n. to 7 ox. by vol.—Nitrous acid gas—nitric acid—Mur. acid little—Water—Nitrate or Nitrite of potash when heated left alkali—chlorate potassa and little chloride of potassium—with sul. acid gave euchlorine.

Another experiment left no chlorate of potassa—but nitrate of potash mixed with a little chloride of potassium. No Ammoniacal salt remained. Hence this mixture of N. Am. and Chlo. potassa gives on heating results nearly according to a mixture of nit. potassa and *chlorate of ammonia*.

OCTR. 1, 1822.

Nitric acid + Chlorate of potassa—heated in a tube gave very yellow euchlorine, as bright as that from Sul. acid and Chlorate—apparently a little chlorine and oxygen gas at last exploded. When the action completed left a mixture of nitre and perchlorate of potassa. The action very like that of sul. acid.

CHLORATE OF
POTASSA + NITRIC
ACID, PHOSPHORIC
ACID, CARB. OF
AMMONIA.

Phosphoric acid + chlorate of potassa—slow action until the acid concentrated, then liberation of euchlorine with mixture of

CHLORATE OF
POTASSA + NITRIC
ACID, PHOSPHORIC
ACID, CARB. OF
AMMONIA.

little chlorine and oxygen—no chlorate left, but perchlorate apparently formed.

3 Chlorate of potassa + 2 sub carb. amm.—well mixed. Could not make it detonate by percussion—heated in a tube—much ammonia liberated—carb. amm. sublimed—rise of heat occasioned liberation over water of carbonic acid, little azote and oxygen—appears not to be much action on the salt; slight decomposition of the ammonia and apparently a little nitric acid formed.

HERSCHELL
NEUTRAL PER
SUL. IRON.

Neutral per sul. of Iron and carb. ammonia prepared according to Mr. Herschell does not appear to be a simple salt but a double one, containing ammonia, for when precipitated by Prussiate of Potassa a dark grey green powder is obtained which, when well washed and dried, contains abundance of water. It is a compound of per oxide of Iron, ammonia and I believe prussic acid. Alkalies or lime take the acid and liberate the oxide of Iron and ammonia. Acids removed the ammonia and leave prussian blue.

OCTR. 2ND, 1822.

HEAT OF VAPOUR
FROM SOLUTION.

Flask containing $20\frac{1}{2}$ oz.

3 oz. of solution subcarb. potassa boiling at 240° F.

Thermometer entirely in the flask stood at 212° F., but was wet and might be kept at that point from the water trickling down it.

Wound some tow round the stem to prevent water trickling on to the bulb, then heated the bulb up to 212° and introduced it into the flask—it still stood at 212° , not rising higher.

Thermometer lowered into solution 240° .

Then raised into the vapour but not cleaned 238° .

Raised higher 234° .

Lowered but still in the vapour 234° ; but a drop had gathered on it which had gradually diluted the salt adhering to it.

Thermometer in solution now 246° F.

„ „ the vapour just above solution but not cleaned 244° F.

2nd Expt. The solution by this time much evaporated and now salt deposited so as to make a cream like mixture, the heat 272° ; and now a thermometer, guarded as before by tow and heated up to 212° or 220° , was further elevated by the vapour about an

inch from the solution to 240° . There was not more steam than before, but it was evidently higher heated, and apparently to me by mere contact with the hot solution. HEAT OF VAPOUR
FROM SOLUTION.

3rd Expt. Solution diluted till boiled at 252° F.

Thermometer cleaned, guarded by tow and the *whole* heated up to 250° . Then suddenly introduced into the flask about 1.5 inch above surface—it immediately sank slowly to 234° F. and then appeared stationary for about a minute; took it out and found a slight spot of salt on it (thrown up by boiling). Put in again at 212° rose slowly to 220° , and then taken out; much salt on it.

4th Expt. Pure water boiling in a flask. Thermometer cleaned and tow'd as before, heated up to 250° and then introduced into the flask as in former expt., sank slowly—but with more rapidity when near the surface of the water than when far from it—evidently because small portions of water falling on it were converted into steam and lowered its temperature; whereas with expt. 3 small quantities of salt thrown up in the same way by ebullition preserved the thermometer hot.

OCTR. 3, 1822.

Expts. with large boiler; contains 35 pints.

Put into it $11\frac{1}{4}$ pints of sol. of nitre boiling at 240° .

Boiler placed *in* the furnace and fire placed round the sides so as to heat the sides as well as bottom; plenty of steam.

Solution boiled at 238° or 240° .

Larger thermometer (mercurial) guarded by tow as before, cleaned and heated up to 240° ; stem as well as bulb put into boiler through a hole in the wooden cover and placed (the bulb) about 3 inches from the solution—it slowly fell to 230° and still continued to fall: when taken out a sprinkling of salt on it.

Thermometer clean, etc. and at 212° put into the boiler; rose 3 or 4 degrees very slowly—when taken out a sprinkling of salt on the bulb.

Repeated: the same results.

When the solution was at 243° from concentration by evaporation another clean heated thermometer at 212° was put into it; it rose very slowly, though when taken out only minute spots

HEAT OF VAPOUR of salt on it. Incline to think that here the vapour was higher
FROM SOLUTION. than 212° .

Expt. 2nd.

Same boiler, etc. Sol. at 235° boiling.

Same thermometer clean, guarded, etc., heated up to 212° —introduced—gradually rose 3 or 4 degrees, but taken out, spots of salt on it.

Again rose to 217° ; after about 3 minutes rose no higher, but taken out much salt on it in state of solution in spots—the other parts clean and dry.

Expt. 3.

Sol. at 235° . A much smaller mercurial thermometer used—guarded, etc., heated up to 212° , then put into the vapour; gradually rose to 216° but not higher, and when taken out bulb quite clean.

Here the vapour must have been hotter than 212° but the excess did not seem many degrees, though the solution was at 235° and the sides of the vessel hot.

Exp. 4th.

Sol. at 235° boiling, etc.

Little thermometer clean, guarded, etc.—put cold into the steam rose up to 212° and remained there. In this case instrument continued wet.

Put in not quite 212° rose to 212° and remained there. In this case a little wet.

Put in when at 212° and dry, gradually rose to 216° and no higher. In this case clean and dry—no salt.

Put in when at 220° fell slowly—did not wait for whole fall—taken out clean and dry.

Heat of vapour seems above 212° but only a few degrees.

OCTR. 8TH, 1822.

TEMP. OF VAPOUR
FROM SOLUTIONS.

The double tin case used; diameter of inner vessel, above $8\frac{1}{2}$ inches, below $7\frac{1}{2}$ inches. Height of the vessel $12\frac{3}{4}$ inches.

Solution put round side to keep the side hot. pints of sol. of nitre put into the vessel capable of boiling at . Plenty of steam in all the experiments. The cover was of wood. Depth of mass of salt when cold, 3 inches.



Small mercurial thermometer used guarded by tow and heated and dried as before—perfectly clean.

TEMP. OF VAPOUR
FROM SOLUTIONS.

Expt. 1. Solution boiling at 236° .

Side at 228°

Thermometer 6.75 inches above the quiescent surface of solution.

„ 3.25 inches below the lower side of the cover.

Cover 10 inches nearly from surface of the solution.

Time 7^h 0' — thermometer at 240° introduced

7' — „ „ 224°

15' — „ „ 223° —taken out, much salt had

been thrown up on to the bulb—so much that when the thermometer had been heated up to 212° and was then introduced into steam from pure water the temp. rose to 220° and then fell from dilution.

Expt. 2. Arrangements as above.

Solution at 236°

Side at . . 228° .

8^h 10' therm. at 219° introduced

12.5 „ „ 223°

14 „ „ 224°

17 „ „ 224°

— shortly after fell to 212° ; the excess of water had ran through the tow and wet the bulb. Could not tell the quantity of salt on the bulb.

Exp. 3. Sol. at 238°

Side at 232°

8^h 44' therm. at 220° introduced

47' „ „ 222°

49' „ „ 224°

53' „ „ 225°

60 „ „ 225° —solution now at 242° and solid salt depositing. Thermometer taken out found spotted by salt, so that when heated to 212° and put into vapour of pure water rose to 215° ; then fell.

Exp. 4. Solution at beginning 233° —at end 237°

Side at „ „ 229°

TEMP. OF VAPOUR
FROM SOLUTIONS.

9^h 16' therm. at 280° introduced

17 " " 250°

18 " " 230°

19 " " 223°

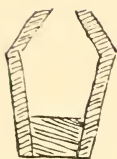
20' " " 220°

21' " " 218°

25 " " 218°—thermometer taken out, bottom spotted with salt. When heated to 212° and put in vapour from pure water rose to 214°.

Solution at 237° at end of experiment.

OCTR. 11, 1822.



The same tin boiler as in last experiments but conical tops put on so as to contract the aperture—perpendicular height from angle to top inches—diameter of inner aperture inches. Small mercurial thermometer used.

Temperature of side 231°

" " solution 231°·5

Exp. 1. 8^h 31' thermometer heated to 260° introduced

32' " " 238°

33' " " 232°

34' " " 230°

35' " " 228°

36' " " 227°

37' " " 227°

40' " " 227°

43' " " 227°

45' " " 227°·5—taken out—only

three very little spots of salt on it, quite dry and clean otherwise—it was suffered to sink to 210°; put in again

8^h 47' 210°

49 222°

51 226°

53 227°

55 227°

Solution now at 238°

Side as before at 231°

Exp. 2. Side 228° Soln. 235° 9^h 25' thermometer 260° introduced27 " 234° 29 " 227° 31 " 226° 33 " 227° 35 " $227^{\circ} \cdot 5$ 37 " $227^{\circ} \cdot 5$ Solution at 237° Side at 228° TEMP. OF VAPOUR
FROM SOLUTIONS.

Here the vapour was only a very little below the temperature of the side, though a good deal below that of the solution. Query the possibility that the bulb of the thermometer could have been cooled by conduction from the upper part of the stem, which itself must have been nearly 212° . If not then the vapour must have risen from the solution at least below 227° , probably several degrees, as the sides would continually tend to raise its temperature after liberation. Use the large thermometer and ascertain the effect when near the top of boiler and when lower down. Ought to be cooler below than above if sides have any influence in heating.

OCTR. 29TH.

Carefull expts. with double boiler, conical top.

Quantity of solution inside

Depth of it

Quantity of space for vapour

Depth from aperture to surface of solution

" " angle to Do.

Diameter of boiler

Height of the side

Height to the top



Expt. 1. Bulb of thermometer clean, guarded by tow and heated, placed at the height of the angle.

Inside — 232° outside — 229° 

TEMP. OF VAPOUR
FROM SOLUTIONS.7^h 8' therm. 280 introduced

10 — 257

11 — 249

13 — 242

16 — 237

19 — 235.5

21 — 235

23 — 235

27 — 235

29 — 235.5 taken out

Inside — 239°

outside — 230°

Did not look at bulb of therm.

Thermometer put lower.

Inside — 232°

outside — 230°

7^h 45' — 240 introduced

46 — 238

48 — 235

50 — 233.5

53 — 233.5—begins to rise slowly—

taken out—much salt on it.

Inside 235

Outside 230

Expt. 3.

Inside — 235

Outside— 230

8^h 0. — 240 introduced

4 — 236.5

6 — 236

8 — 236.5—taken out; a little salt on it.

Inside 240

Outside 230

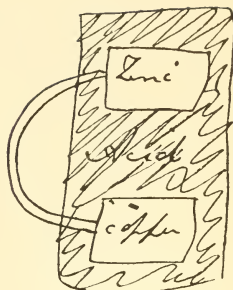
I think Gay Lussac must be right. A little salt on the bulb would not preserve the temp. high for any length of time unless the vapour were high also, for it would gradually become diluted and sink to temp. of the vapour.



Dr. Seebeck's Expt. An. Phil. N.S. Vol. iv. p. 318.

Bar of Antimony and brass wire: the bar being heated at one end the north pole of a needle would go round it as represented in the lower figure*—the effect on the needle very decided, powerful even and constant.

The dotted lines represent the state of the wire as ascertained from former experiments. The side diagram represents a combination with the wire in the same state.



OCTR. 23, 1822.

Oxide of Chromium heated in a tube with chlorate of potassa—powerful action with liberation of chlorine and production of chromate of potassa—curious. CHROMIC COMPOUNDS.

Chromate of potassa with a certain proportion, not too large, of Mur. amm. heated red gives oxide of Chromium by washing.

Oxide of chromium heated in atmosphere of oxygen—no change.

Red chromate of lead fuses and crystallises beautifully by heat.

Yellow chromate of lead acted on by excess of ammonia—chromate of ammonia formed and a red chromate of lead.

Red chromate of mercury and excess of ammonia form chromate of ammonia and black chromate of mercury.

Chromate of potash, sulphuric acid and sugar—heated, form sul. chromium and much acetic acid rises in vapour, which may be readily condensed by cold surfaces.

Action of heat on chromic compounds (change of colour).

Yellow chromate of potash becomes bright red.

Green oxide chromium becomes brown green.

Red chrom. mercury becomes dark red, almost black.

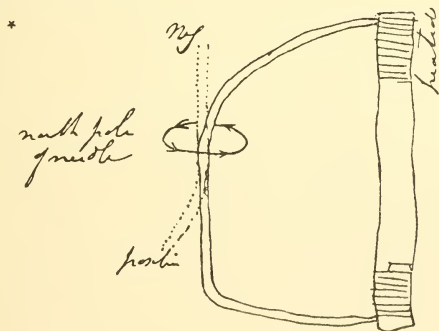
Yellow chrom. lead becomes brown.

Red chrom. lead becomes dark red or black.

Light yellow chrom. barytes becomes orange yellow.

Novr. 2. Chromate of Soda forms large crystals resembling in appearance Rochelle salts, but they fuse like ice at temperatures of about 70° , as for instance in the hand.

Chromate of ammonia heated is decomposed in a singular way. It runs up like burning horn—ignites and liberates much gaseous matter—chromic oxide is left.



ALCOHOL AND
N. M. ACID.

Considerably diluted Alcohol + diluted N. M. Acid was distilled and portions received separately. The first portions were a little ethereal but they had a powerful smell like that from the ignited wire in ether and affected the nose strongly just in the same way. The taste was very hot, like cayenne or horse radish, and in that resembles the other vapour. They were slightly acid to litmus, the acid being I believe the acetic. They precipitated very slightly with nitrate of silver, but much more abundantly with proto nit. of mercury: in this analogous to lampic acid. Added to acid solution of gold with a small drop of Ammonia to neutralise it reduce[d] the gold a little and partly coated the tube: then like lampic acid. The hot taste and peculiar odour diminished in the 3, 4, 5, 6, etc. portions, and when about half over the further portions were more acid, precipitated more with Nit. Silver like M. A. The portion left in the retort was yellow, highly acid, dissolved Gold, etc. etc.; it was N. M. Acid. None of the distilled portions would dissolve gold.

Diluted Alcohol + diluted N. Acid pure.

DECR. 12, 1822.

The Alcohol N. M. Acid of preceding page¹—contains much Mur. acid now—neutralised with potash—precipitates proto nit. Mercury—by heat did not reduce it—does not now taste so hot as before—scarcely at all, and to me now no smell—is principally a mur. pot., but when burnt became alkaline, hence destructible acid present. Mur. Acid also, for with N. A. and N. of S. precipitated abundantly.

NOVR. 26, 1822.

CHROMATE
POTASH—ACETIC
ACID, ETC.

Chromate Potassa + excess of Sul. acid boiled together: no change in 2 hours.

Chromate potassa + excess sul. acid + a little sugar—boiled—immediately the intense yellow colour went and the solution became green from the conversion of chromic acid into chromic oxide. The vapour that rose being condensed in a glass was acid, but not sulphuric. To the smell it was acetic acid. When there

¹ See Novr. 26 above.

was enough sugar the conversion of the chromic acid into chromic oxide was complete.

CHROMATE
POTASH—ACETIC
ACID, ETC.

Chromate potassa + excess of Sul. acid + a little Alcohol—heated—immediate conversion of chromic acid into oxide; liberation of vapours like those from ether by hot wire and also of acid fumes not precipitated by mur. barytes; they appeared to be vinegar.

Chromate potassa + excess sul. acid—heated. Oxalic acid dropped in: immediate liberation of gas and change of colour—required much oxalic acid to make solution green and then not the pure green of the former solutions. If N. A. were added to this solution it produced no immediate change, but if ammonia were added it first threw down a precipitate which, in a few minutes, was almost redissolved, and then either before or after filtration the addition of N. A. gave a beautiful red solution. Query what oxide.

Chromate of potassa + excess of Sul. acid + Acetic acid—boiled for two hours—no change at all.

DECR. 2, 1822.

Sulphuretted hydrogen gas and *pure* Mur. Acid have no action on each other whether in solution (both or one) or as gases or in solar light or not.

SUL. HY. AND
MUR. ACID.

DECR. 16.

Acetic acid from Acet. Pot. by Sulphuric Acid and pure—boiled with proto nit. mercury does not reduce it—it throws down slowly small quantity of scaly crystals, soluble by heat or in enough water—no precipitate with per nit. mercury—does not precipitate nitrate of silver. Query very strong solution.

CHROMATE OF
POTASSA—ACETIC
ACID, ETC.

Pure Acet. pot.—precipitates proto nit. mercury—by dilution or small heat redissolves—more heat—does not reduce the mercury—does not precipitate per nit. Mercury. It precipitated nit. of silver, but resolvable in enough water.

Acetate of silver soluble but not much so.

Acetate of potash—no carbonic oxide with strong sulphuric acid.

Dobereiner's acid from Manganate, tartaric acid, etc. does reduce proto nit. mercury when heated with it.

Its potash salt precipitates proto nit. mercury when cold—when heated reduces it—evaporated, formed a deliquescent salt—gave carb. oxid. with sulphuric acid.

Mixture (Chromate potassa, Sul. Acid, Water) with *Alcohol*: distilled and products collected—redistilled to purify. The acid obtained tastes like vinegar—does not reduce proto nit. mercury. Its potash salt—does not reduce it neither—with S. A. gave very little *Carb. oxide*—smelled very strongly of acetic acid—salt very deliquescent. Seems to be principally acetic acid with a little of Dobereiner's acid.

Mixture and Sugar—First acid distilled off was worked with—when purified was weak—reduced Proto N. of Mer. readily. Its potash salt reduced proto nit. mercury readily but dirtily—was deliquescent and gave abundance of carbonic oxide with Sul. Acid.

Repeated the experiment: same result exactly.

No charring in these expts.

Mixture and Various substances—Acid purified and made into salt with potash—strong sol. precipitated proto nit. mercury—by heat reduced it—reduced N. of Silver also—dry salt deliquescent—gave plenty of Carb. oxide with Sul. Acid—appears to be Dobereiner's acid.

Lampic acid with little lamp. barytes—from Mr. Daniell—reduces proto nit. mercury readily. Its potash salt precipitates proto nit. mercury white like A. of Pot.—by heat blackens and is reduced—sol. strong—mercury flocculent—with S. Acid gives plenty Carb. oxide.

The spirits distilled from Nitro lampic and lampic acids both reduce proto nit. mercury.

Mixture and oxalic acid—heated gave off abundance of Carbonic acid gas—no carb. oxide—no condensible acid came over though carefully sought for—the solution no[t] so green as the others and peculiar—to be examined—(does the oxalic acid changed remain or not; is *all* decomposed?)

S. A. + Water + Sugar—distilled—various portions drawn off—all like Dobereiner's acid—both in reduction of Mercury and production of Carbonic oxide with S. A. Water added now and then to prevent too much charring of the sugar—much acid obtained and all like Dobereiner's. At last Suls. Acid came off

and stopped the process. This perhaps better than Dobereiner's process.

JAN Y. 2, 1823.

Mixture and Ammonia—left acid—no action by boiling. Chromate potassa and Sul. Ammonia mixed and boiled—no action.

Mixture and olive oil—no effect after 10 minutes boiling.

Mixture and Camphor—no effect after 10 minutes boiling.

Mixture and Rosin—reduced the chromic acid to chromic oxide. Query volatile acid or the change on the resin.

Mixture and oil of turpentine—reduced the chromic acid to chromic oxide by boiling, and though slowly yet completely.

Mixture and Gum—boiled, reduction to chromic oxide—smell of Volatile acid—distilled—first product reduced proto nit. mercury—and neutralised with potash—the salt gave abundance of Carb. oxide with Sulphuric acid.

Gum and Sul. acid—difficult to distil from carbonization of gum—rises up and runs over.

Mixture and Acetic Acid—the acetic acid distilled off nearly as it went on—with proto nit. mercury it formed Acetate of mercury which heated dissolved in the water and there appeared very faint traces of reduction of mercury; but when cold again the acetate of mercury crystallised. The potash salt gave no Carb. oxide to sulphuric acid.

Mixture and Ether—even in the cold the chromic acid became chromic oxide if the sol. of mixture was strong. When weak, boiling immediately produced the change. I could not perceive the liberation of any gas—there were minute bubbles in both cases but too small by far to be examined or to be a result of decomposition. Query the acid or substance produced.

Chromate of potash and oxalic acid—with a little heat very powerful action. Abundance of gas liberated: was Carbonic acid, and the solution became strongly green. Query the oxide produced here. Is it the green oxide?

FEB Y. 5.

Mixture and Ether—distilled—plenty of acid came over. It did not reduce proto nit. mercury. Its potash salt—abundant, did not

reduce salt of mercury and gave no carb. oxide to sulphuric acid. When burnt it left carb. potash and with sulphuric acid gave fumes of Acetic acid.

Sugar and Muriatic acid diluted $\frac{1}{2}$ water. The acid distilled off a mixture of M. A. and Dobereiner's acid—proto nit. mercury put too—the calomel filtered out and then the solution, having excess of proto nitrate, was heated—mercury was reduced. The potash salt, heated, gave mur. potash and carb. potash—reduced as before. In sulphuric acid gave a gas which on washing proved to be a mixture of about equal parts of Mur. acid and Carbonic oxide.

FEBY. 11TH.

Sugar and N. A. with bulk of water distilled. Distilled nearly to charring—the Acid contained no vegetable acid but nit. with little mur. acid—put some water in retort and then again distilled—weak acid came over, a little Nit. and Mur., but it reduced Proto nit. of mercury and also Nit. Silver—there was very little of it. Continued the distillation until substance black and charred—strong acid product—precipitates N. of S. and proto nit. mercury, whitish, like chlorine—filtered and heated then reduction of the mercury—potash salt—no oxalic acid in it for no precipitate with lime solutions—salt brown with strong peculiar odour like triple compd. of Chlor., Carb. and hydrogen—on evaporation, when hot, thick and gummy; when cold, hard. Gave abundance of Carb. oxide to Sul. Acid.

Sugar and N. M. acid—with water—an acid came off which, after neutralization by potash, precipitation with Proto N. of Mercury and filtration gave on boiling signs of reduction of mercury—the dry salt and Sul. Acid—much Mur. and Carb. acid but no Carb. oxide or at least very minute quantity.

1823. JAN. 16.

HYDRATE OF
CHLORINE.

Solution of chlorine in a stopper bottle put in a cold place—cooled to 28° F, agitation then made it crystallise—left all night—next morning more crystals in it but greatest part fluid—the temperature about $\frac{1}{2}$ a degree lower than ice cold or rather snow cold water—temp. the same in another Jar, where crystals of hydrate of chlorine were undissolved—crystals taken out of the

bottle and washed well in distilled water; were then pure ice—and when dissolved did not precipitate nitrate of silver.

HYDRATE OF
CHLORINE.

A little water put into a jar of chlorine and left in a cold place. Hydrate of chlorine formed, a little water added and the hydrate washed together—was in crystalline plates and films—sometimes it shoots out in long prismatic or needle crystals into the atmosphere of a bottle of chlorine; at other times forms an arborescent film on its inner surface. The substance is of a bright yellow colour; it does not dissolve readily in water unless the particles be small and thin, and then a solution just like a solution of chlorine results—water to which the crystals had been added, when tested by nit. Silver, gave plenty of precipitate, and it formed beautifully round the crystals of hydrate remaining undissolved.

Put into water and the temp. gradually raised, chlorine began to liberate as gas at heats between 44° and 48° ; at 48° crystals gave off gas with moderate rapidity. The crystals sink rapidly in water when of a moderate size and are probably of a S. G. of 1.2 or 1.3.

Put into sul. acid, heat is produced from the water present and the hydrate is decomposed, giving gas—in Mur. lime also, but perhaps the solution not cold enough.

Put into Alcohol—there was considerable elevation of temperature, 8° or 10° or more—a gas or vapour rose from the crystals as they lay in the alcohol, but it did not rise far before it was condensed in the liquid—a dense fluid appeared about the crystals which was miscible with the alcohol—and the crystals rapidly diminished in volume, at first giving a yellowish tint to the alcohol, which soon disappeared. The alcohol examined contained abundance of Mur. Acid (very much); also ether smell and on evaporation left a little of a substance which charred by heat—a minute globule of gas was liberated during this action: it appeared to be azote, probably from air in the alcohol.

The crystals put into solution of Ammonia acted on it, liberating nitrogen gas and forming muriatic acid (with slight smell of azotane?). In salts of ammonia (mur.) it liberated a little nitrogen gas, formed muriatic acid and also azotane which remained undissolved at the bottom of the solution.

HYDRATE OF CHLORINE. 39.2 gr. crystals well pressed in bibulous paper weighed—in water cold and weak ammonia added, was left for 28 hours—action during this time—then heated a little, the excess of ammonia neutralised by N. A. and the Mur. acid formed precipitated by Nit. Silver, 35.5 gr. chloride of silver were obtained = 8.75 gr. chlorine which, plus 30.45 gr. water = 39.2. This is about 14 prop. water to 1 chlorine.

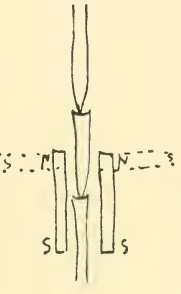
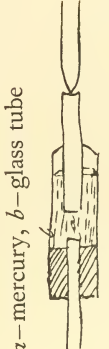
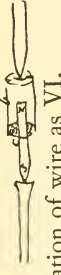
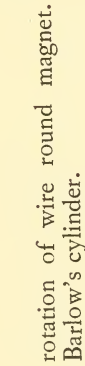
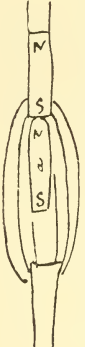
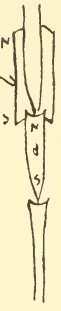
1823. JANU. 20.

Again 65 gr. pressed crystals were put into flask with diluted ammonia (cold)—action rather stronger than before—once a slight smell of azotane at mouth of flask, but much ammonia in excess—left for 24 hours—then heated, filtered, neutralised by pure N. Acid and thrown down by Nit. Silver, 73.2 gr. chloride of silver were obtained = by scale to 18.1 chlorine }
 hence $\frac{46.9}{65}$ water } or 1 prop.
 10 prop.

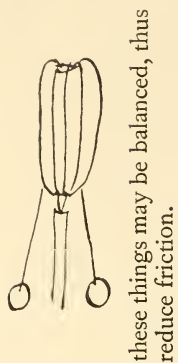
JANU. 25TH.

COLOURED PLATE GLASS. Some pieces of plate glass said to change colour and become pink by exposure to light and air. 3 pieces marked across, then each cut in half; 3 halves sealed up and put by—the 3 other halves exposed to light and air, to remain so—the pieces have now a pale pink tint.

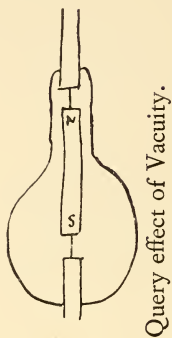
Expected results in Electro Magnetism.

- I Jany. 28th.  rotation of wire round magnet pole.
- II  rotation of a wire on its own axis.
- III Jany. 21.  rotation of 2 wires on their axes.
- IV  rotation of magnet round wire.
- V  rotation of wire on its axis.
- VI  rotation of magnet on its own axis.
- VII  rotation of 2 magnets on their axes.
- VIII  *b*—a cylinder, *c*—fixed here
rotation of wire as VI.
- IX  rotation of wire round magnet.
Barlow's cylinder.
- X  both poles of magnet round wire.
- XI  both poles of magnet round fixed wire as X.
- XII  *a*—brass ferrell amalgamated
rotation of magnet in fixed wires.
- XIII Jany. 21  All fixed but *a*—it will revolve on its own axis.
- XIV  posite *b* variously to *a*; try also horse shoe and bar magnets.
- XV  rotation of wire round pole.

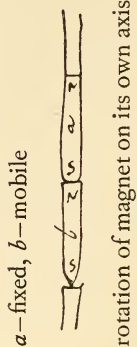
XVI



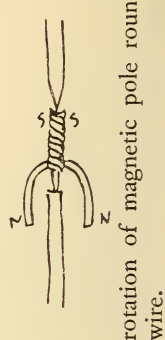
XVII



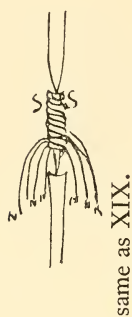
XVIII



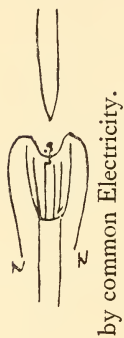
XIX Jany. 27th.



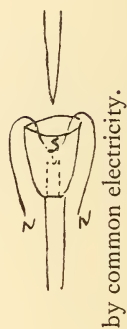
XX Jany. 27th.



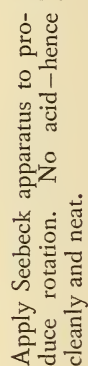
XXI



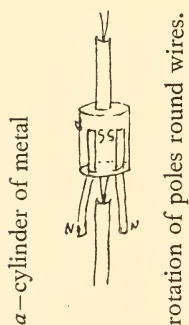
XXII



XXIII



XXIV Jany. 27th.



1823. JANY. 21ST OR 22ND.

Tried to make Magnet rotate round the wire III, using cylinder and also bar magnets; could not succeed though suspension very delicate. ELECTRO
MAGNETISM.

Tried to make Magnet revolve in a circle of wires XIII; would not do—no tendency to motion.

It appears the action does not regard the material substance at the centre but simply the current of electricity or the magnetic pole, the substance merely giving locality to the power. In that case, when the current or the pole is not in the centre of motion, it in acting by producing rotation must carry the material with it; but when in the centre it produces all its effect without affecting the substance or making it revolve. Hence a wire placed to revolve round a Magnetic pole has no tendency in the way of reaction to make the pole or magnet revolve on its axis. Nor if the wire be a series of wires or a cylinder surrdg. the pole will it have any action of this kind. Nor would a pole have any reaction on a wire active in making it revolve so as to make the wire rotate on its own axis.

If this be true, then in my rotation apparatus the wire ought to move equally well though the magnet turned with it. Also the magnet ought to move round the wire though the wire turned with it. Hence also such an expt. as XIX and XXIV ought to succeed where the conducting medium incloses the pole not to be used. No, for reason on Jany. 23, etc. Hence however such expts. as depended on reaction, as I, II, III, IV, VII, X, XIII, cannot probably succeed.

JANY. 22.

Tried rotation of wire round magnet, both fixed together—did very well. Also tried rotation of magnetic pole round wire: did not do quite so well but motion very distinct—the mercury was dirty—apparatus small and power weak—but it was evident that the body at the centre might turn with that describing a circle without interference.

There must I think be some very peculiar state of the powers when a magnet is made part of the electric circuit, but it is a

ELECTRO
MAGNETISM.

question whether, being exerted in the substance of the magnet, we shall ever make them sensible.

* Rotation by repulsion. Let the ends of the wires be bent at right angles and guarded by a glass tube or cement; then inwards in a dish of mercury. Make communication by dish and wire *a* and rotation from repulsion ought to take place.

† As they are not either of them in the centre of motion, and the one pole of magnet is *enveloped* in the conducting medium, the thing ought to revolve.

JANY. 23.

If the north pole N endeavours to go round the wire as a watch hand moves then the S pole will try to go the other way round the crank and consequently there is no reason to expect rotation of the whole: try xxiv and xxix and xix.

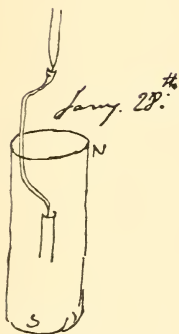
1823. JANY. 27TH.

Again tried the rotation of wire and magnet round each other, the two being fixed together so as to move at once, as on the 22nd. Did very well indeed—motion free and constant.

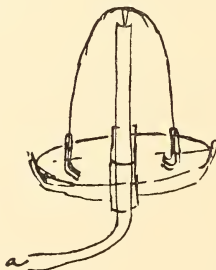
Tried an apparatus like the xix, but could get no indications of motion or rotation though the suspension on a needle point was very free. Tried also one like the xxiv, but could not get any effect at all. Now and then I thought there were faint indications, but the motion or rather the suspension was not free and the tendency of the whole to one side or the other might cause it. See Jany. 23.

The one in the margin should revolve; it is merely another form of the common rotating apparatus having the magnet on the outside instead of the centre. Nevertheless there is a question arises from the cylindrical form of the magnet—its rotation independent of the metal and reaction. If a cylinder does not do, can a series of small magnets do? No.

XXX



* XXVIII



† XXIX



Tried xxx; got no effect. Query are not the powers which tend to make it move in any one direction neutralised by the others.

Tried xxix. No tendency to Motion. It could not be expected any more than in xxiv.

Tried vi. No tendency to Motion.

vi, viii, xix, xx, xxiv, xxix are the common apparatus with a solid medium in place of the fluid mercury. Hence the thing essential to the permission of motion was absent.



1823. MARCH 18.

FLUID SUL-
PHUROUS ACID.

Mercury + Sul. acid: sealed up and heated in tube plenty of action and much sulphate of mercury produced—by degrees a limpid colourless fluid passed over which, when the action had been continued for a short time only, would again mix with the sulphuric acid in the tube; but when the sulphuric acid was saturated with sulphurous acid it would not mix with it but remained separate, floating on it. When the saturated sulphuric acid was distilled it gave off gas which condensed into the fluid.

A tube containing the fluid opened—it did not explode or the substance instantly pass into vapour but it quickly evaporated, producing cold. It was not so rapid in its evaporation as the fluid chlorine. It entirely evaporated, producing no visible fumes, but the pure smell of sulphurous acid—hence not a compound of sulphuric and sulphurous acids.

The gas which first rises on heating is rapidly absorbed by the Sulphuric acid under this pressure but the after portions distil into the further end of the vessel.

A tube opened under mercury, the liquid expanded into sulphurous acid gas. Water added to a portion of it, there was immediate ebullition from the heat communicated—sulphurous acid gas was evolved and a solution of sulphurous acid formed. The fluid does not solidify or thicken at 0° F.—Feby.¹ 20th—Have made abundance of the fluid. To prove it dry made some sulphurous acid gas over mercury—dried the chlorine tube—exhausted it—filled it with the gas—by a syringe threw in 5 or 6 atmospheres more of the gas—the tube at common temperatures appeared perfectly clear and dry—but on cooling one end to 0° the fluid sulphurous acid came down, and in limpidity, evaporability under atmospheric pressure, etc. etc. was exactly like that prepared in the other way.

Ascertain temp. by evaporation by a thermometer. It does not freeze mercury.

¹ March: preceding dates have been altered in MS. from February to March.

Sulphuret of Iron and Muriatic acid—in tube sealed up, then brought into contact and heated to 200° . Much gas liberated and some sulphur. After some time distillation separated a very fluid colourless body, not miscible with the rest of the fluid in the tube—it was very volatile. The tube opened did not burst asunder, but the fluid expanded into sulphuretted hydrogen, leaving no residuum. Feby.¹ 19th. Tube opened under water, fluid expanded into *Sul. hy. gas*—does not thicken or solidify at 0° —is very volatile, more so than sulphurous acid.

FLUID
SULPHURETTED
HYDROGEN.

MARCH 19TH.

Sulphuric acid + chlorate of potash in tubes sealed up—Feby.¹ 20th. Have now been 24 hours—S. A. and salt dark brown colour, atmosphere bright yellow, distilled between 100° and 0° . After some trials fluid euchlorine obtained—by degrees the S. A. and salt lost their dark colour and became light yellow, and a very fluid ethereal looking body condensed in the cold part—not miscible with a small portion of the sulphuric acid which lay beneath it, but if returned back on to the mass of acid and salt it soon spread through it, apparently combining with and rendering it of a much deeper colour even in places than itself. Its colour was deep yellow, becoming bright yellow where the tube was thinly moistened with it.

FLUID
EUCHLORINE.

One tube containing a portion of it at the clean end was opened at the opposite extremity—there was a rush of gas but the salt plugged up the atmosphere. Whilst clearing this away the whole tube burst with a violent explosion, except the small end in a cloth in my hand, where the euchlorine previously lay—but it had all disappeared.

1823. MARCH 19TH.

After many trials for carbonic acid at last obtained it. A tube containing Sul. Acid + Carb. Amm. was sealed up some days ago—but no results by distillation or otherwise obtained—today by cooling one part to 0° the atmosphere suddenly condensed and formed a transparent colourless limpid fluid—not miscible

FLUID
CARBONIC ACID.

¹ March: preceding dates have been altered in MS. from February to March.

FLUID with the S. A., etc. in the tube and distilling backwards and for-
CARBONIC ACID. wards at temperatures of 50° and 0° . After a while the tube sud-
denly burst spontaneously, shattering a basin containing freezing
mixture in which it was placed.

Feb'y.¹ 20th. Put some more tubes to work and very soon
obtained plenty of fluid carbonic acid again—appearance just as
before.

1823. MARCH.

Chlorine
Muriatic acid
Sulphurous acid
Sulphuretted hydrogen
Carbonic acid
Euchlorine
Nitrous oxide
Cyanogen
Ammonia

✓ <i>Cyanogen</i>	fluoboric acid✓
✓ <i>Ammonia</i>	Hydriodic acid
Arseniuretted hydrogen	✓ <i>Muriatic acid</i>
Phosphuretted hydrogen	Hydrophosphoric gas✓
✓ <i>Sulphuretted hydrogen</i>	✓ <i>Nitrous oxide</i>
Hydrogen	Nitric oxide✓
Nitrogen✓	Nitrous acid
Oxygen✓	Phosgene gas
✓ <i>Carbonic acid</i>	Potassiuretted hydrogen
Carbonic oxide	Seleniuretted hydrogen
Carburetted hydrogen	Silicated fluoric acid✓
Olefiant gas✓	Telluretted hydrogen
✓ <i>Chlorine</i>	✓ <i>Sulphurous acid</i>
✓ <i>Euchlorine</i>	Hydrophosphoric gas✓

1823. MARCH 19TH.

FLUID Put Nit. of Ammonia (dry as could be) into 2 glass tubes and
NITROUS OXIDE. sealed them up. Then heated one end of each to decompose the

¹ March: preceding dates have been altered in MS. from February to March.

salt—the larger tube soon burst with powerful explosion—the smaller stood. After some time 2 fluids passed over, not miscible with each other. The pressure, estimated by a bubble of fluid, was between 20 and 30 atmospheres. When the whole had been distilled and left to cool there was no separation of the resulting fluid but was one uniform transparent portion—March 20th.—Found nothing was done by raising the temperature of the fluid: none rose—but on cooling a part of the tube to 0° there was an abundant deposition of a very limpid, colourless, ethereal looking fluid that would not mix with the fluid before in the tube but floated on it. By taking the tube from the mixture and leaving it in the atmosphere the whole again disappeared, leaving only the comparatively tenacious adhesive fluid (the bore of the tube small; this probably water). So that the Ns. oxide, if it prove to be that body, is wholly in the state of vapour. This appears to be Cagniard de la Tour's expt. The body is at these temperatures just at the point where it will become either fluid or vapour.

FLUID
NITROUS OXIDE.

MARCH 21.

Another tube about half filled with dry nit. ammonia and the salt then carefully decomposed; the further end of the tube being cooled by filtering paper (wet). The fluids produced was distilled a second time. Now there was a good deal of the ethereal colourless fluid N. Ox. at common temperatures, so that there had not been vapour enough in the former tube. When the tube was cooled a great deal more was deposited. The tube and fluid being at 50° , if the empty end were cooled to 0° the fluid immediately boiled and distilled to the cool end.

The first tube had the end opened: the fluid immediately rushed out into vapour and left that end of the tube dry. The tube did not fly to pieces, so that may open it under water and collect the gas.

March 26th. Opened a nitrous oxide tube under water and collected the gas. It proved to be as expected, Ns. oxide. The water left in the tube was acid, and on evaporation acid fumes arose, but no Nit. of Ammonia remained. What is the nature of this acid and how is it produced?

See March 26.

PHOSPHURETTED
HYDROGEN. Prepared two tubes with Mur. acid and phosphuret of lime—
inverted the tube—strong action, much heat and liberation of gas—
and an apparent deposition of phosphorus—left till a future time.

March 26. One of these tube[s] burst spontaneously with a
violent explosion. The other had one end cooled to 0° but no
fluid separated. One end was then cooled to 0° whilst the other
was raised to 200° , but still nothing condensed. The end of the
tube was then broken and the whole burst with a very loud
explosion and large flame. There must have been great pressure
within, although insufficient to produce fluid at 0° .

MARCH 21.

AMMONIA. Prepared two tubes with dry Mur. Ammonia and dry and
caustic quick lime—distil tomorrow.

1823. MARCH 26TH.

HYDROGEN. A tube with zinc and somewhat diluted sulphuric acid pre-
pared nearly a week ago. Much action and much sulphate of zinc
formed but all endeavours to condense the hydrogen failed. At
last the tube, though very thick, burst with a violent explosion
spontaneously.

NITROUS OXIDE. See March 19th.

Two tubes had been prepared with Nitrous oxide from Nit.
Ammonia—internal diameter $\cdot 135$ of inch each and uniform
throughout—external diameter $\cdot 305$ of an inch, consequently glass
 $\cdot 085$ of an inch thick. The tubes may be called A and B, and the
conical termination being estimated as well as could be of a
cylindrical form, the following marks and measures refer to the
length of the inside of the tubes, which may therefore be con-
sidered as cylinders.

*A tube**

a to *f*—internal length of tube 8.5 inches.

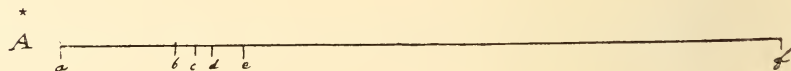
a to *b*—water 1.5 inches.

b to *c*—fluid nitrous oxide at temp. of 45° = .21 of inch.

b to *d* " " " " 35° = .38 of inch.

b to *e* " " " " 5° = .72 of inch.

e to *f*—atmosphere at temp. of 5° = 6.28 inches.



*B tube**

NITROUS OXIDE.

<i>a</i> to <i>f</i> internal length of tube	8.67 inches.
<i>a</i> to <i>b</i> —water	1.24 "
<i>b</i> to <i>c</i> fluid nitrous oxide at temp. of 45°	0.15 "
<i>b</i> to <i>d</i> " " " " 35°	0.40 "
<i>b</i> to <i>e</i> " " " " 5°	0.80 "
<i>e</i> to <i>f</i> atmosphere at temp. of 5°	6.63 "

I cannot reconcile these proportions. I think there must be some other bodies than Nitrous oxide and water formed from Nitrate of Ammonia; and those volatile.

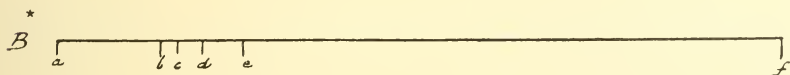
1823. MARCH 27TH.

Pure cyanuret of mercury, well dried and inclosed in a green glass tube—heated, obtained fluid cyanogen—limpid, colourless and very fluid—tube cut or broken, fluid immediately became gas, leaving tube dry—expansion within not very great, so that tube easily cut in half in the hand. FLUID
CYANOGEN.

March 28. A tube with fluid cyanogen open under water at the end farthest from the cyanogen, so that the mercury, charred matter, etc. retarded the liberation of the vapour. As soon as the end was cut the gas issued out and the whole of the fluid evaporated gradually as the gas liberated.

Another tube opened under mercury: the vapour, collected in a jar and examined, was pure cyanogen.

A narrow tube prepared with cyanuret of mercury at one end and a globule of mercury including a portion of air at the other to measure the pressure. Heat applied until a portion of fluid cyanogen produced and the volume of the air within the mercury marked—the tube opened and the point to which the mercury returned marked—temp. being 45°. These two spaces compared by the weight of mercury they held and were 293 gr. and 67 gr.—hence $\frac{293}{67} = 4.37$ atmospheres at 45°. All this is not however due to the force of the vapour of cyanogen at 45°, for a part of the pressure will be due to the air still mixed with it. The space was perhaps enlarged $\frac{1}{3}$ by the advance of the globule so that about $\frac{2}{3}$ of an atmosphere, or .7, might be due to this air; hence the



FLUID pressure of the cyanogen vapour at 45° about 3.6 or 3.7 atmospheres.
CYANOGEN.

Another tube prepared, the fluid cyanogen distilled to one end (the prussiate mercury had not been decomposed at a high heat that liberation of nitrogen might be avoided) and its bulk marked off. The tube opened and cyanogen allowed to evaporate—all fluid disappeared and there was loss of weight 4.5 gr. Water equal to bulk of fluid cyanogen = 4.2 gr. The capacity of the whole tube = 466 gr. mercury—space occupied by fluid cyanogen, mercury and black matter = 143 gr., hence vapour atmosphere = 323 gr. mercury in bulk = 0.0946 of c: i:. This multiplied by 3.7 the number of atmospheres = .34982 of a c: i: at common pressure, and as 100 c: i: cyanogen = 54.9 gr., the .34982 c: i: = 0.192 of a gr. Now $4.5 - 0.192 = 4.308$, the weight nearly of the fluid cyanogen, and $\frac{4.308}{4.200} = 1.0257$, S. G. of fluid cyanogen at 45° .

Put a little water in the tube for trial.

A tube with cyanogen opened in the air so that cyanogen gradually became vapour. The tube became excessively cold and instantly froze the atmospheric vapour on its exterior.

OXYGEN. Chlorate of potassa dried was put into a thick glass tube (green) one end of which was preserved moist by water; the other was heated by a lamp so as to decompose the salt but not soften the green glass—after some time and action, when no condensation could be perceived, a violent explosion took place—hence great pressure and low temp. for oxygen.

1823. MARCH 29.

FLUID Prepared a cyanogen tube with a little water in it—the fluid
CYANOGEN. cyanogen not miscible with water—and decidedly lighter than that fluid—apparently not so much lighter as ether would be—looking at objects through the tube containing the water and cyanogen, both in and out of water, the refractive power of the cyanogen was found to be rather less than that of water—temp. in these expts. 45° .

FLUOSILICIC Prepared a tube with fluor spar, glass and sulphuric acid—as
GAS. yet apparently no liquid product—distil on Monday.

April 1. Could get no results by distilling between 212° and 0° ; distilled by lamp and 0° , could get no results still—at last very violent explosion—great fume from an immense volume of fluo-silicic gas set free and silica deposited on the ice near.

March 29th. A tube with sulphurous acid prepared with a mercurial guage attached. The spaces marked where the mercury stood at first and when fluid sulphurous acid had been produced, temp. being both times 45° . The spaces estimated by weight of mercury were 84.7 gr. and 27.8 gr.—now $\frac{84.7}{27.8} = 3.05$ atmospheres within the tube, but as the air within the tube was but little expanded by moving of mercury in guage, it equalled 1 atmosphere nearly—hence Suls. acid at $45^{\circ} = 2$ atmospheres.

Prepared a tube with boracic acid, fluorspar and Sulphuric acid—heated, much action—distilled by lamp and ice, but no condensation of fluid—the Sul. acid appears to dissolve the fluoboric gas too readily.

Prepared some Amm. gas over mercury—dried some chloride of silver—put it in the ammonia and absorbed the gas—the saturated chloride put into a tube and sealed up—then heated by a lamp at one end whilst tube cooled to 0° at the other. The chloride fuses at a very low temperature comparatively, giving off ammoniacal gas—which condensed at the other end and formed fluid ammonia.

April 1. Ammonia tube—plenty fluid ammonia. When tube taken out of mixture and chloride allowed to cool, the ammonia soon began to return to the chloride. It combined with it producing heat, and at the same time evaporated from the opposite end producing cold. When chloride cooled to 50° the ammonia at opposite end would boil at 60° , from the vapour required to combine with the chloride.

The tube thus arranged may be compared with the Cryophorus and called a Calo-cryophorus.

1823. APRIL 1.

Voltaic Electricity. 50 one inch plates passed through chlorine and Sulphurous acid: they conduct so as even to allow a spark with charcoal and the decomposition of water; but no gas or

CONDUCTING POWER. other appearance of decomposition in the substances appeared. Repeat.

REFRACTIVE POWER. Refractive power—ascertained as well as could be by viewing objects, as letters, etc. through the tubes and similar tubes containing water, both in the air and in water at temp. of 50° .

Nitrous oxide—very much less than water—half way between water and air.

Muriatic acid—less than water—greater than nitrous oxide—nearer to N. oxide than to water.

Carbonic acid—much less than water—verging towards Nitrous oxide—perhaps about M. A.

Chlorine—rather less than water.

Cyanogen—very like water, perhaps a little less.

Sulphurous acid—as near as may be water.

Sulphuretted hydrogen—near water; perhaps rather more—decidedly a little more—than Suls. acid.

Ammonia—decidedly more than water.

APRIL 2.

MURIATIC ACID PRESSURE. Muriatic acid—endeavoured to ascertain pressure within—prepared a tube having inclosed in it a mercurial guage. When action had produced liquid mur. acid observed the compression: 133 parts of air became 4.6 parts— $\frac{133}{4.6} = 28.9$, which minus the .9 for atmosphere of air = 28 atmospheres at 32° .

At temp. of 50° it was $\frac{133}{3.84} = 34.4 - 1 = 33.4$ the number of atmospheres at 50° .

SUL. HYDROGEN PRESSURE. Sul. Hydrogen tube for pressure prepared with guage: 91 of air at common pressure became 6.5: now $\frac{91}{6.5} = 14$ which minus about 1 for common air gives 13 atmospheres at 32° .

At temp. of 50° it was $\frac{91}{5.8} = 15.69 - \text{about } 1 = 14.7$ atmospheres at 50° .

APRIL 10TH.

SULPHUROUS ACID. Opened a tube with sulphurous acid, dipped the outside in water and left a drop hanging to it. The water immediately froze. Put a small piece of ice at 32° into the sulphurous acid; the latter immediately boiled from the heat communicated by the ice, but

when the ice had been cooled by the evaporation it remained unchanged in the sulphurous acid. SULPHUROUS ACID.

Pressure of Nitrous oxide by guage.

157 parts of air became 3.482 parts by pressure of vapour at 32°. NITROUS OXIDE
PRESSURE.

Now $\frac{157}{3.482} - 1 = 44$ atmospheres, which is therefore the pressure of nitrous oxide vapour at 32°.

The 157 parts became 3 parts at temp. of 45°. $\frac{157}{3} - 1 = 51.33$ atmospheres for the strength of vapour at 45° F.

1823. APRIL 16.

Hydrate of chlorine in a tube with a guage, then decomposed by heat until free fluid chlorine. 6 degrees in the guage became 1.2 degrees, hence $\frac{6}{1.2} - 1 = 4$ for number of atmospheres of pressure of chlorine vapour at 60°. Tube soon after burst, on continuing the heat. PRESSURE OF
CHLORINE VAPOUR.

1823. APRIL 17TH.

High pressure vapour lamp.

Bent a tube as in margin—introduced cyanuret of mercury at *c*: fastened on a cap and stop cock *a*, *b*. Then heated *c* and cooled *d* until cyanogen issued from stop-cock. Closed the stop-cock and continued the heat; fluid cyanogen collected at *d*. When the whole had gained common temperature opened the cock and lighted the jet of cyanogen vapour which issued out. It continued (and also the flame) till all the fluid had disappeared as vapour. Mr. Millington saw this experiment and I mentioned to Mr. P. Taylor yesterday and to Mr. Brande this morning, my expectations on this point. Now search among combustible gases for one becoming a liquid under 8 or 10 or even 20 atmospheres at common temperatures; examine oil gas products, etc. Mentioned to Phillip at Royal Society in the eveng. of this day at time Sir H. Davy's paper read.

HIGH PRESSURE
VAPOUR LAMP.



Prepared some dry ammonia and chloride of silver; saturated the chloride and put it into a bent tube with a guage—liberated the ammonia by heat and fused the chloride into lumps, so that the surface being diminished the ammonia could not readily PRESSURE OF
AMMONIA.

PRESSURE OF AMMONIA. recombine—thus got plenty of liquid ammonia which remained unabsorbed for an hour or more. The common air had been expelled from the tube by part of the ammonia before sealing, so that all the pressure noted afterward was due to the ammonia vapour.

12 parts of air at common pressure became 2.4—hence $\frac{12}{2.4} = 5$ atmospheres at 32° F.

12 parts became 1.83; now $\frac{12}{1.83} = 6.55$ atmospheres at 50° F.

1823. APRIL 16TH.

PRESSURE OF CARBONIC ACID.

Carbonic acid produced in a tube containing a guage. There was enough produced to leave some in the liquid state at 10° or 12° F, but as the tube had cracked in one part I was afraid to urge it for the production of more liquid for higher temperatures. But at 0° F, 24.25 parts of air were condensed to .842 of part. Hence $\frac{24.25}{.842} - 1 = 27.8$ atmospheres for force of vapour of Carbonic acid at 0° F.

1823. MAY 3RD.

Another experiment, but tube again cracked—however, could experiment at temp. below 32° and with more accuracy than above. At 22°, 52 parts of air became 1.75 = 30 atmospheres—and at 32°, when there was hardly fluid enough, the 52 parts became 1.45 parts = 36 atmospheres.

1823. APRIL 30TH.

SPECIFIC GRAVITY OF AMMONIA.

Hydrometer Bulbs made of glass. Tried their S. G. and found them to be as follows:

I	one	lighter	than	ether	of	.772
II	one	„	„	„	„	.908
III	„	„	„	„	„	.916
IV	„	„	„	„	„	1.053
V	„	„	„	„	„	1.098
VI	„	„	„	„	„	1.102
VII	„	„	„	„	„	1.133
VIII	„	„	„	„	„	1.133

IX	one	lighter	than	ether	of	1.220
X	"	"	"	"	"	1.434
XI	"	"	"	"	"	1.500
XII	"	"	"	"	"	1.580

SPECIFIC GRAVITY
OF AMMONIA.

Put the I into an ammonia tube, sealed it up and liberated the liquid ammonia until enough to cover the bulb was obtained. The bulb just floated in it, coming to the top, but more slowly than in ether of .772, and judging from the difference of effect I observed whilst graduating these bulbs, as produced by a small alteration of S. G. of the solution containing them, I should think the S. G. of the fluid ammonia to be about 0.76 very nearly. Query degree of penetration when mixed with water?

A bulb introduced into sulphurous acid tube in the same way. The bulb was No. VI; it floated however with much force, the little stem rising out of the liquid. As much was got together as could be, and the tube when cold opened; then hooking out the VI, No. IX was put in. It floated also strongly, and being taken out X was put in. I believe it sank, but so much liquid had evaporated, enough did not remain. No. X was therefore put into another tube and a fresh portion of suls. acid made about it. It was now found to sink slowly in the fluid. I judge the Specific Gravity of Sulphurous acid to be 1.42.

S. G. OF SUL-
PHUROUS ACID.

Every time the platina wire was put in to the sulphurous acid it made it boil and became so cold that when applied to the tongue quickly it froze to it. I could not perceive any taste in the suls. acid—try its reddening powers.

Tried cyanogen for S. G.; put in bulb II. It sank in the liquid slowly. Its Specific Gravity therefore is 0.9 or a little less.

S. G. OF CYANOGEN.

May 3rd. Tried Sulphuretted hydrogen for S. G.—got a bulb in (III), and also free from all adhering water and mur. acid. The bulb sank in the liquid but not with great velocity. S. G. I think about .9, certainly not .916.

S. G. OF SUL. HYDN.

1823. JUNE 26TH.

See 1826. Sept. 15th.

Made a mixture of 1 vol. oxygen + 2 vols. hydrogen, filled 5 dry bottles over mercury with the mixture and also 4 bottles over water—left them in glasses inverted over mercury and water—

OXYGEN AND HY-
DROGEN: SPON-
TANEOUS ACTION.

OXYGEN AND HY-
DROGEN: SPON-
TANEOUS ACTION.

having previously placed 3 mercury and 2 water bottles in the windows so as to receive the sun's rays and daylight, and put the other 2 mercury and 2 water bottles by in a dark place.

Sept. 3rd. The mercury in the dry bottles in light, black at the surface with thick film; one has a little moisture within. Opened one of the water bottles—was no expansion or contraction of volume—43 vols. of gas gave 10 vols. of oxygen to nitrous gas. In consequence of evaporation the bottles have been left dry round the stopper on the outside.

1824. July. Examined the bottles—the water bottle in sun light contained a little hydrogen and rest common air: no alteration of volume. The mercury bottle in light contained common air only. The water bottles in dark place, water right on outside—no change in volume of gas—it was the original mixture. The mercury bottles in dark place contained nothing but common air. Hence mercury cannot confine gases perfectly—hence also no combination in the dark—nor (most probably) in the light either.

1823. AUG. 20TH.

RADIATION.
DEW. MIST.

At Folkestone, the atmosphere clear and a fine view of the cliffs to Dover. Soon after sun set (the wind being about S.S.W. so as to blow on land) observed a cloud forming just above the brow of Shakespeare cliff. It streamed inwards, increasing in size, but all seemed to pour nearly from the same spot; the air which came from over the sea there taking on a visible form and passing in to the interior as a cloud. By degrees the generation of cloud took place along the whole line of cliff from Dover to Folkestone hill, the wind still carrying the portion formed over the land. We ascended the cliffs about $\frac{1}{2}$ a mile beyond Folkestone hill about an hour after sunset and found all above enveloped in a dense moist mist, so as to deposit water on our cloaths; the temperature also low to the feelings. We walked back towards Folkestone and on descending a little way down the hill by the road emerged from the cloud and found all clear beneath. The cloud now extended a considerable way in land, covering the tops of the hills. Was not this effect produced by the cooling of the surface of these hills after the sunset by radiation into the clear space

above, and the consequent cooling of the moist air brought by the wind from the sea below its point of deposition? RADIATION.
DEW. MIST.

We saw a smaller effect of the same kind a few evenings before in similar circumstances at the same place—and also over the land of Romney marsh.

1823. AUG.

Flying of Gulls, hawks, etc. Folkestone.

FLYING.

At times when the wind has been rather strong I have frequently watched the gulls who were flying over the waves looking for food, and have often seen them move slowly against the wind or remain stationary facing it, balancing themselves on their wings but without flapping them. This has lasted for 1, 2, 3 or more minutes, and I think could not be due to any previously acquired momentum because they would suddenly sweep round, going down with the wind, and then again return against it, all without flapping the wings. I have also remarked hawks over land advance in a similar manner in similar circumstances, without having been able to detect any motion of the wing calculated to support them. They seemed to remain suspended in the air by an apparent balancing of the body on the wings against the wind.

Sometimes similar appearances were observed in situations where it might be accounted for. Thus I have seen gulls and hawks leave a resting place in a cliff, move in to the free space and poize themselves whilst they examined the ground beneath, and without a single flap of the wing; but the wind has in these cases been blowing on to the land, and being thrown upward against the face of the cliff may have produced a current upwards abundantly sufficient to support the bird. But I have seen the same thing many times with gulls, and once with a hawk, w[h]ere the birds moved out clearly into the horizontal current and where the means they used to support themselves escaped my perception.

Last year when at Swansea and standing on the end of the pier I noticed a gull coming up across the mouth of the harbour against a westerly wind in this manner, without flapping the wings. On coming to a spot a little beyond me it returned with

FLYING. the wind to the place from where it came up, and again renewed its course towards me; this I remarked done 7 or 8 times, occupying above a quarter of an hour, and with only an occasional flap of the wing now and then.

How do these birds fly? and why may not a man or a machine fly in the same way in the same circumstances?

See notes Aug. 3, 1824.

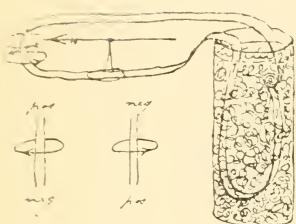
SEPT. 3.

DIAMOND AND
FLUXES.

Heated diamond with borax, nitre and other fluxes on Platinum wire by blow pipe. No action, or at least a very slight one: no remarkable effects.

1823. SEPT. 9TH.

VOLTAIC ELEC-
TRICITY.



A plate or band of sheet zinc about 2 feet long, $\frac{1}{2}$ inch wide and $\frac{1}{30}$ thick was coiled together at the two ends so as to form an endless band and put into a jar of strong sul. acid solution as in the figure. When the action was well established there was a deviation of the magnetic needle in the direction of the upper circle. When a rod of zinc was dipped into the acid and made to touch the band at 1 or 1 this deviation was increased, or when a rod of copper touched the band at 2 the same effect was produced; but when the zinc touched at 2 or the copper at 1 or 1 then the deviation was in the direction of the lower circle.

OCTR. 31.

CYANURET
MERCURY.

Ferro prussiate potash and turpeth mineral boiled together *become very alkaline.*

Let there be excess of turpeth, then the solution obtained after boiling contains no ferro prussiate of potash, and on being crystallised yields crystals at first which appear to be a cyanuret of mercury. If collected and recrystallised they still do not resemble common cyanuret of mercury in form, and when heated fuse more readily and yield I think much more cyanogen; they are probably a bi- or tri-cyanuret of mercury or contain a still higher proportion.

Ferro prussiate of potash and the proto-sulphate of mercury boiled with the latter in excess yield a solution containing no

ferro prussiate of potash and giving much cyanuret of mercury of the well known kind—but the mother liquor contains a mixture with sul. potash.

CYANURET
MERCURY.

1823. NOVR. 3.

Steel Alloys, etc.

ALLOYS.

- I Platinum and Steel welded.
- II Do. " " "
- III Twisted and forged steel to imitate Damascus.
- IV Pure iron fused.
- V Iron with 3 per cent Rhodium.
- VI Iron with 3 per cent Nickel.
- VII Steel 50, Platinum 50.
- VIII Steel 20, Platinum 80.
- IX Steel 50, Rhodium 50.

1823. NOVR. 14.

Muriatic acid added in excess to solution of hydro-sulphuret of ammonia—turbidness appeared and in a short time a strong smell of *sulphurous acid*. The hydrosulphuret contained sulphite of ammonia. There is no action on the pure compound of sul. hydrogen and ammonia except liberation of Sul. hy.

Solution of chlorine added to sol. of Mur. amm. and left a while till Azotane formed; then added Hydro sulphuret of ammonia in excess—a pleasant odorous smell produced, something like chloride of carbon, but no traces of Sulphuret of Nitrogen.

SULPHURET
NITROGEN.

Carbonate of ammonia added in excess to lime water dissolves the carbonate first thrown down and the lime is not then detectable by oxalate of ammonia, ammonia, potash or carb. pot.; but phosphate of soda throws it down. Mur. or other salt of lime with Carb. ammonia—similar effects.

CARB. LIME.

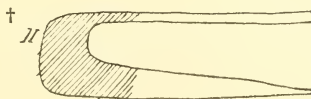
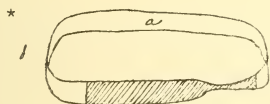
Could not get this to succeed again; see Octr. 1, 1824.

1823. NOVR. 17.

I a complete circle of zinc*—the shaded part immersed in acid, but no magnetic effects produced.

ELECTRO-
MAGNETISM.

II a piece of copper†—the shaded part heated whilst the extremes connected with a magnetometer: no effect. I cut and opened out at *a* and connected with the magnetometer—no effects.



SULPHURET OF
NITROGEN.

Solution of chlorine added to weak sol. of hydrosulphuret of ammonia—when chlorine in excess, sulphur and sulphurane separated and the mixture became odorous—when hydrosulphuret of ammonia in excess it smelled simply of it.

Solutions of amm., chlorine and sulphuretted hydrogen: similar effects.

Solution of Mur. Amm. mixed with little sul. hydrogen and ammonia, then chlorine placed over it: sulphur was deposited as the action went on but no appearance of a sulphuret of nitrogen.

Chlorine was placed over sol. of mur. ammonia until the solution saturated with chlorine of nitrogen and slowly yielding bubbles of gas from every part—this solution mixed with sol. of sul. hydrogen and hydro sulphuret of ammonia—the liberation of gas stopped and the mixture became turbid—allowed to subside, the substance was collected and appeared like sulphur; it was dried and heated in a tube with mercury—it yielded a small bubble of sulphuretted hydrogen but *no nitrogen*.

NOV. 19.

BI SULPHURET
OF COPPER.

Nitric acid strong but cold added to artificial sulphuret of copper—acid soon neutralized if not in excess—nitrous acid and nitric oxide given out—nitrate of copper and a little sulphuric acid formed—and a decided peculiar smell like that of weak nitric acid on fat or flesh—no traces by alcohol or otherwise of any thing peculiar like $S + N$ —when acid in excess, the sulphuret being powdered and the action left in the cold to complete itself, another sulphuret of copper resulted which, washed and dried, was of a greenish black colour—when heated gave out abundance of sulphur and when decomposed in a tube by strong red heat gave off[f] nearly 1 proportion of sulphur, leaving 1 proportion of sulphuret of copper—hence it is an artificial bisulphuret of copper.

This bisulphuret of copper acted on by *hot* N. A. was decomposed yielding nitrate of copper—sulphur—sulphuric acid—nitrous acid and nitric oxide—but no $S + N$.

N. A. ON SULRT. TIN.

Nitric acid on sulphuret of tin—cold, little action—heated, action—oxide of tin—sulphuric acid—nitrous acid—nitric oxide, but apparently no $S + N$. The peculiar smell was again evident.

Made to act in close vessels and the gas examined, it proved to be *nitrogen*; whilst the solution was so strong of nitrous acid as to be of a blue colour. When boiled the Ns. acid flew off and a little oxide of tin was thrown down. N. A. ON SULRT. TIN.

Nitric acid, dilute, on Solution of hydro sulrt. lime made by boiling lime, sulphur and water together—strong smell of sul. hydrogen, and the hydro sul. left in such proportion as to leave this smell in excess—abundant precipitate—no liberation of gas—the precipitate left for 12 hours was a soft, solid substance which, heated in a tube over mercury, gave out a little sulphuretted hydrogen and left sulphur and sulphuret of mercury. N. A. ON SULRT. LIME.

1823. NOVR. 20TH.

Nitric acid pure on cinnaber—at first dissolved a little sulphuret of copper—afterwards no action at all by boiling even—but the cinnaber was very highly *improved in colour*. N. A. ON CINNABER.

Muriatic acid on Cinnaber: after first boiling no action—but N. M. Acid rapidly dissolved cinnaber, producing cor. sub., oxy. nit. mercury, sulphuric acid and sulphur.

NOVR. 21.

Sulphuret of tin with diluted N. A. at low temperature—action; oxide of tin—Nit. tin—and Nitric oxide gas—apparently no *N+S*. N. A. AND SULRT. TIN.

NOVR. 22.

Solution of Mur. Amm. in Mur. acid: put chlorate of potash into it to see whether Azotane would be conveniently formed. It was formed and was evident to the smell and eyes, but did not collect in drops. Process will not do better or so well as the known one. AZOTANE.

Chloride of sulphur poured into solution of ammonia—strong action, the solution becoming brown, but then clearing and yielding a brown coagulum. CHLORIDE SULPHUR IN AMMONIA.

The solution contained Mur. ammonia, but I could find nothing particular in it. I did not observe the liberation of gaseous nitrogen during the action. The red brown substance, when collected, was a soft body not soluble in water, alcohol or ether,

CHLORIDE SULPHUR
IN AMMONIA.

but apparently soluble in boiling oil of turpentine, for it disappeared almost entirely. Heated in the open air it fused and burnt producing sulphurous acid. Heated in a glass tube in contact with mercury it gave cinnaber, sulphurous acid gas and a small portion of a fluid. In another expt., tube more highly heated, strong fume of ammonia—perhaps adhering to the substance. Solution of potash acted on the substance, first deepening its colour and then becoming pale—the potash contained a little sulphuretted hydrogen.

Substance looked something like an oxide of phosphorus—but not at all like $N + S$.

CHLORIDE SULPHUR
AND AMMONIACAL
GAS.

Some chloride sulphur was put into a tube and ammoniacal gas passed over it—strong action with heat—much mur. ammonia formed—the fluid disappeared and a solid body of brown and yellow colour appeared—insoluble in water and something like sulphur. It was not so red as the substance obtained in the fluid way and was more brittle. It appeared by its action over mercury to be sulphur with a little sulphuretted hydrogen, but contain no nitrogen. Nitrogen was given off during the first action of the Amm. gas on the chloride, occupying the capacity of the tube.

CAMOMILE
FLOWERS.

A strong infusion of camomile flowers was acidulated by sul. acid—it became very turbid and being left for several days deposited a substance insoluble in water but soluble in Alcohol and in alkalies. The Alcoholic solution was filtered and set aside to evaporate spontaneously. *

Another portion of the Alcoholic solution (being of a brown colour) was boiled with animal charcoal; the colour was considerably removed but the solution would not now precipitate by water, which it did before.

A portion of the infusion was precipitated by nitrate of lead: all the substance went down with the lead. The precipitate washed and then boiled with sul. soda and a little ammonia gave a deep brown solution—this was boiled with animal charcoal without much improvement of colour, and then after filtration a little sul. acid added to it—an abundant precipitate took place. This, washed and collected, proved to be a compound of lead and vegetable matter. It was not further examined because it did not appear to be the substance I wanted.

* This portion has deposited a white granulated substance but mixed with impurity here and there and having water laying over it. Examined by the microscope it did not appear crystalline. A part was filtered and wash[ed] with water; another part had weak potash added to it and many drops of the Alkali were neutralized by it. It was filtered and the neutral *brown* solution evaporated. CAMOMILE FLOWERS.

The purer granulated portions were separated and again dissolved in alcohol; in spontaneous evaporation a white granulated mass like the first was obtained. This was soaked in water for a night and the water poured off: tested by Mur. bary. a precipitate (slight) appeared but not like sul. barytes. It was washed with more water and then dissolved in alcohol: solution brownish—reddens litmus decidedly and requires many drops of soda solution to neutralise it. The neutral solution precipitated strongly by sulphuric acid—more feebly by Mur. acid and not at all by N. acid—left to evaporate.

See Decr. 10th.

A closed tube 30 inches long filled with mercury and inverted in mercury. A little ether sent up and the place where the mercury stood marked. Sulphuret of carbon sent up in addition: the mercury stood at the same place. MIXED VAPOURS.

DEC. 4.

Some arseniuretted hydrogen made in Stromeyer's way—my tube exhausted and filled with it and then 6 or 8 atmospheres more forced in—the end of the tube then cooled, first to 32° and then to 0° F: a slight dew occasioned, but no condensation of the gas into a liquid. ARSENIURETTED HYDROGEN.

DEC. 10TH.

Powdered oxalic acid has been left in an atmosphere of chlorine for 10 or 12 days. It now seems a dry dirty powder—but examined it appeared to have undergone very little change—dropped into water, there were no signs of carbonic acid though the solution gave chloride of silver with N.S., probably from adhering chlorine. OXALIC ACID IN CHLORINE.

CHLORINE AND
WATER.

Solution of chlorine in sun light 2 days: has given a bubble which when examined proved to be oxygen.

Mur. Acid tinged by sul. indigo—left with an atmosphere exposed to sun light—no decomposition, no change of the colour of the indigo. Jany. 15, no change up to this time.

DEC. 10.

CAMOMILE
PRINCIPLE.

See Dec. 1.

The alkaline salt in solution tested by the addition of the following substances and with the following effects

Mur. lime	precipitates, not abundantly
Mur. baryta	Do. — little
Mur. Strontian	Scarcely
Mur. Magnesia	None
✓Mur. Manganese	rather abundant
Per sul. Iron	no precipitate, but dark brown colour
✓Mur. zinc	very abundant yellow precipitate
proto Mur. tin not in excess	} yellow precipitate
Mur. copper	
✓Nit. lead	greenish precipitate
Tart. Ant. and potash	dense precipitate
Nit. Cobalt	none
✓Mur. Cerium	none
Nit. Nickel	dense precipitate
✓proto nit. mercury	white green precipitate
Nit. Silver	dense white precipitate
Mur. Alumine	slight
	little

Precipitates not mentioned as colour were white or yellow white.

1823. DECR. 17TH.

CHAMOMILE
PRINCIPLE.

Strong infusion of chamomile flowers—precipitates abundantly with sulphuric acid—boiled with animal charcoal (large quantity) the solution changed colour, but did not after filtration precipitate by sulphuric acid—but when boiled with powdered box wood charcoal it still retains *the principle* in solution.

Strong infusion—nit. lead—then sul. acid in slight excess. Strong precipitate—which soon subsided—washed two or three times—filtered—and digested the precipitate in alcohol, but no particular substance separated by it, for alcoholic solution did not precipitate with water—the salt of lead dried and heated burned, still retaining the substance.

CHAMOMILE
PRINCIPLE.

Carbonic acid thrown into Strong infusion : no precipitation.

Neither the substance nor any of its compounds yield ammonia by heat.

QUARTO VOLUME II
OF MANUSCRIPT

DEC R. 10TH, 1823.

SOME oil of turpentine with twice its bulk of strong muriatic acid put in a bottle, shaken and left, has now been 4 days and is of a dark colour but does not seem to have formed artificial camphor. Feby. 11. Still the same—no interesting change.

M. A. AND OIL OF
TURPENTINE.

DEC R. 24TH.

See

Tamarind Stones. They did not yield ammonia as some I formerly tried did—they were soaked in water and then scraped, by which the white central part was obtained clean and pure—a portion of the dry substance put into strong sulphuric acid and heated yielded carbon, carbonic oxide and water? Heat was required for the action.

TAMARIND STONES.

After steeping in water for 24 or 30 hours the matter was beaten up into a mucilaginous pulp and a little dilute Sul. acid added; this, left for 24 hours, had deposited most of the substance. The fluid poured off, neutralised by cream of lime, filtered (which it did readily) and the dried residuum digested in hot alcohol and filtered. This evaporated yielded an oily substance, combustible, not soluble in water but with diluted sul. acid yielding a pinkish solution not precipitable by alkali—the oil evidently dissolved slightly in the sul. acid.

The pulp left by the acid was washed in many waters and then had an acid apple odour: it did not [] nor was it soluble except very slightly in cold water; not therefore like gum. When boiled in water it swelled and thickened something in the manner of starch; more water added and the whole filtered gave a solid part insoluble in further portions of water and a liquid which when cold appeared slightly mucilaginous, and on the addition of alcohol appeared like a solid Jelly. When evaporated it seemed like a weak solution of albumen but left very little solid matter. Iodine gave no precipitate or colour with it, nor did nit. lead. Infusion of galls precipitated it whitish. Corrosive sublimate did not precipitate it. Sub acetate of lead has the same effect as alcohol. The substance appears to be vegetable jelly.

Alcohol will not dissolve the solid portion; heated in oil it

TAMARIND STONES. does not dissolve but ultimately chars. Alkali dissolved a little of it and was precipitated again by acid.

A large portion of the softened pulp was boiled in a smaller quantity of water; it formed a starchy like mass which when hot flowed about and when cold had not gelatinised like animal jelly. Abundance of water was added; the whole boiled and suffered to separate by standing and the insoluble portion washed in repeated portions of fresh distilled water. It was then filtered out and dried and though white at first became yellow by drying. It somewhat resembled soft Gluten, and what is remarkable it yielded ammonia by destructive distillation, though in small quantity.

DEC R. 26TH.

NITROUS OXIDE ON
HYDROSULPHURETS
OF METALS.

A solution of proto sulphate of Iron and another of manganese were precipitated by hydrosulphuret of ammonia and the precipitates well washed out of the contact of air. The first was black, the second white or buff coloured. These mixed with water to the consistency of cream were each put into capped retorts, the vessels exhausted and then Nitrous oxide sent in. At first there was action on the sulphuret of Iron and the formation of oxide from the presence of a little air, but that soon ceased, and on the 29th no further change had taken place in either retort.

They were then placed in sun light and left till Jan'y. 2nd. When examined no change had taken place. The moist hydrosulphuret was then boiled in contact with the gas, but no action took place and the nitrous oxide remained unchanged—a little sul. hydrogen came over at the end of the boiling.

1824. JAN Y. 2.

SUL. HY. IN
NIT. AM.

A stream of sul. hydrogen sent into solution of Nit. Amm.; absorption but no further action; the solution placed in sunshine but no action—heated gave out

SUL. ACID AND
ALCOHOL.

Jan'y. 2. Black substance from distillation of Alcohol and sulphuric acid. The mass in the retort liquid when hot but on cooling coagulated like blood, a black jelly like mass being formed and a clear acid separating. Water added to the whole and well

shaken; the black substance insoluble and settled to the bottom. Repeatedly washed with water till all the acid removed; it then dissolved in water forming a black solution smelling something like wallnuts. This solution precipitated by acids, the black matter becoming insoluble. Alcohol does not precipitate it. Evaporated on sand bath, films form on it as if on milk, but not to any great extent. A brilliant black substance left which heated in tube yields water, sulphurous acid, sulphuretted hydrogen, a little sulphur and left charcoal and some apparently earthy matter.

SUL. ACID AND
ALCOHOL.

The black solution evaporated under the air pump left a similar substance which afforded similar products.

JANY. 3.

Some of the above dried substance was boiled in distilled water. It *did not* dissolve in it or undergo any change. But when a portion was rubbed very fine and mixed up even in cold water it produced an uniform liquid which did not deposit any thing in several days and which looked very like a solution. Under the microscope it appeared uniform and no particles could be perceived.

When rubbed up with Alcohol a similar fluid in appearance resulted.

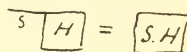
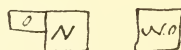
The substance is of greater S. G. than water, sinking when solid rapidly in it. Query, does it form by minute division a true solution or not and how does the action of acids in precipitating the liquids decide. Though the solution be then made denser yet the black substance precipitates.

The aqueous solution prec. by S. A., not immediately by Acetic acid; it does by potash and chlorine slowly destroys its colour.

Some Nitrous oxide was carefully prepared and some sulphuretted hydrogen from Sulphuret of antimony and Muriatic acid.

NITROUS OXIDE
AND SUL. HYDRO-
GEN.

Equal volumes of these gases were mixed and a light applied to a portion in a tube; the mixture inflamed at the aperture but would not burn through the tube—when a little more than half of Nitrous oxide was present the mixture burnt on applying a light to it, the bright blue flame produced passing but slowly through the tube. Water and sulphurous acid were formed, sulphur deposited and probably nitrogen set free.



NITROUS OXIDE
AND SUL. HYDRO-
GEN.

A portion of the equal part mixture was heated over mercury in a tube; no effect was produced though the glass softened until the mercury became heated; then sulphuret of mercury and water were formed and nitrogen set free.

A pellet of finely divided platina (mixed with clay) was put in a tube containing the mixture over mercury; no action. No action up to Jany. 10th.

Another portion was heated, a pellet being inside; the effects were as if no pellet had been present.

A dry retort was filled with the mixture, some spongy platina having been previously introduced. It was then placed where it may receive such sunshine as may occur.

Jany. 17th. The retort examined: no action, the gases just as at first, a mixture of nitrous oxide and sulphuretted hydrogen. There have been several fine sunny days for winter but may try the expt. again in summer.

Feby. 12. Passed equal vols. of nitrous oxide and sul. hydrogen over spongy platinum—no effect at common temp.—when heated sulet. platinum—water—a little suls. acid and nitrogen liberated—no other action.

JANY. 5TH.

NITROUS OXIDE
AND SULET. IRON.

Proto sulphuret of Iron was put into a green glass tube and when heated to dull redness nitrous oxide passed over it; the latter was decomposed, nitrogen was liberated and sulphurous acid and oxide of Iron formed. When heated up to a certain point the action was so strong as to elevate the heat within still higher to a bright red, forming a sort of combustion within. This would be a good process for analysis of nitrous oxide and probably nitric oxide also.

JANY. 15.

NIT. AMM. IN
SUL. HY.

Nitrate of ammonia fused and decomposed in atmosphere of sulphuretted hydrogen—no particular effects—a part of the sulphuretted hydrogen decomposed and sulphur deposited—a mixture of sul. hy. and nitrous oxide left—no sulet. nitrogen formed that could be perceived.

A quantity of the black substance of Jany. 3 dried on sand-bath, pulverised and put into a retort with an atmosphere of chlorine. Much heat and action and a fluid formed—fumes in the retort, a little absorbtion; set aside for 24 hours, then colour of chlorine nearly gone. Let some more in—had been absorbtion; substance still black; no appearance of crystals of chloride of carbon: brought it into day light.

S. A. AND ALCOHOL:
SUBSTANCE IN
CHLORINE.

Prepared some hydrochloride of carbon from Oleft. gas and chlorine, washed it with water and left it over Mur. lime fuzed. A portion of it placed in strong sol. of ammonia and even boiled in it, but no decided action except a slight formation of a film about it, even after 3 or 4 days. Substance still appears as before—it does not dissolve in it but lies like a globule in it. Strong solution of potash had not any immediate action on it nor did it dissolve it.

HYDROCHLORIDE
OF CARBON IN
ALKALIES.

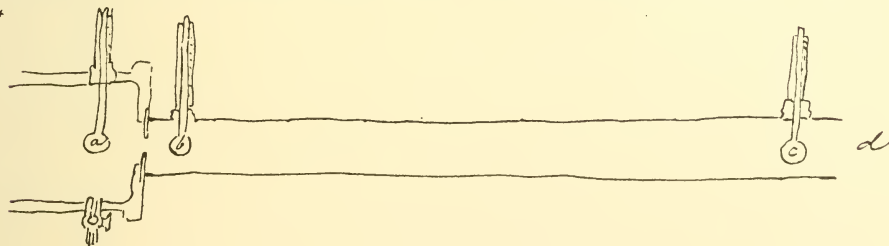
1824. JANY. 16.

With Mr. Ewart at Taylor and Martineau's establishment; Mr. Phillips present. Mr. Ewart's expt. on steam.

EWART'S STEAM
EXPERIMENT.

* A horizontal tube 4 inches in diameter and about 6 feet long was attached to one of T. and M.'s boilers; the extremity of the tube came out into the open air and was closed by a diaphragm perforated in the centre by a half inch hole; a thermometer (No. 1) was fixed in the 4 inch tube about 2 inches from the diaphragm, and a stop cock was fixed in the pipe beneath it to draw off condensed water. A piece of copper tube was prepared about 20 inches long and two inches in diameter. Two thermometers were fixed in it at about an inch from the extremities; they passed through the side of the tube and had their bulbs in its axis. This tube was then fixed on to the larger as an elongation of it, the hole in the diaphragm being made to correspond with the axis of the smaller tube.

Steam was not [? now] let on at a high pressure and allowed to pass freely out at c. The temperatures of the three thermometers were all different but the important one *b* fell as it was removed from its central position and raised or lowered out of the axis of the tube—it was in fact too large in the bulb and formed a serious



EWART'S STEAM
EXPERIMENT.

obstacle to the emission of the steam: the following are some of the temperatures noted

<i>a</i>	<i>b</i>	<i>c</i>
266°	213°	218°
"	204°	"
"	194°	"
"	191°	"
"	189°	"
"	190°	215°

During the whole of the experiment the short tube was so cold as not to boil water from its outside; it was decidedly below 212°. Much water was blown out of it by the force of the steam and must have been such as was condensed by the coldness of the air about in it; the water lined the tube or at least was blown off from all parts of its opening and the little steam that ran off at the bottom was at 190°. A thermometer put in at the open end varied in temperature as it was placed in the axis or side of the tube, the axis of course being hottest. Any variation of the position of thermometer *b* varied the temp. both of *a* and *c* because of the different emission of steam. I do not think the experiment satisfactory, because I think there may have been an eddy in the angle of the tube which might carry the water back to the thermometer *b* when not central, and because the tube was not clothed.

At last thermometer *b* was blown away. Then the following temperatures were noticed with *a* and *c*

<i>a</i>	<i>c</i>
253°	236°
262°	240°
270°	216°
270°	218°
220°	216°
221°	220°
248°	230°
240°	230°
266°	242°

These were intended to shew that after certain temperatures whilst *a* rose—*b* was falling.

565 grains of steel and 16 grains of nickel packed in a crucible together for fusion—Feby. 11. Fused, but being interrupted only imperfectly; must fuse again.

Ultimately failed in furnace.

1824. FEBY.

A portion of Chloride of antimony pure and solid decomposed by water, the powder well washed by repeated portions of water and a crystalline powder obtained which when digested in pure alkaline solution, filtered, the alkali neutralised by nitric acid, again filtered, and precipitated by nitrate of silver yielded for 100 parts—42 parts chloride of silver = 10.3 chlorine.

ANTIMONIAL PRE-
CIPITATES FROM
MURIATES.

A portion of glass of antimony powdered, digested in Mur. acid and a solution obtained which when precipitated by water and washed also yielded a crystalline powder, of which 100 parts yielded 36 parts chloride of silver, 8.9 [chlorine].

A portion of butter of antimony from Fisher's (red-brown liquid) precipitated by water and washed gave an earthy powder yielding per 100 parts only 13 of chloride of silver = 3.2 chlorine.

1824. FEBY. 12.

Air brought home by Mr. Fisher.

45.5 of the air } gave a diminution of 27.8 which divided
26 of hydrogen } by 3 gives 9.2666 or
100 of air contains 20.364 oxygen.

ATMOSPHERIC AIR
FROM THE
NORTHERN
EXPEDITION.

Again, 44.4 of the air }
36.2 of hydrogen } gave a diminution of 27.5 = to 9.166 ox.
100 of the air contain 20.42 oxygen.

56.4 of common air }
44.8 of hydrogen } gave a diminution of 37.3 = to 12.433 ox.
100 of common air contain 22.045 oxygen.

The air brought home in a glass flask only secured by a cap cemented on in the usual manner and a stop cock.

This bottle had formerly contained sul. hydrogen—no trace of that gas now.

ATMOSPHERIC AIR
FROM THE
NORTHERN
EXPEDITION.

Another bottle of air brought home by Mr. Fisher.
Hydrogen tried by a ball; 94 parts diminished to 90.
46.5 parts of the air } gave a diminution of 30.4 from which
34.9 „ „ hydrogen } subtract 1.5 for dim. of hydrogen;
leaves corrected diminution $28.9 = 9.633$ or
100 of the air contains 20.72 oxygen.

Again,
45.2 of the air } gave diminution of 29.5 which minus 1.22 for
28.8 of hydrogen } the hydrogen leaves $28.28 = 9.426$ oxygen or
100 of the air contains 20.85.

61.2 of common air } gave diminution of 41.8 which minus 1.63
38.3 „ hydrogen } for the hydrogen leaves $40.17 = 13.39$ of
oxygen or

100 of common air contains 21.88.

This bottle had formerly contained nitrous oxide gas and now contained the little guage that was then inclosed in it. Query, how was that gas expelled and the common air admitted; in what part of the ship or in what situation and at what temperature. There was a little expansion when opened under water at about 48° .

1824. MARCH 25TH.

SULPHOCYANATE
OF POTASH.

Sulphocyanate of potash prepared by Vogel's method when considerably evaporated and cooled crystallised in a solid mass of needles; evaporated still farther became dry, was then very fluid at heat below dull redness, unchanged by that heat, solidifying upon cooling like nitre and crystallising—and very deliquescent.

SULPHOCYANATE
OF LEAD.

Solution of Sulphocyanate of potash added to acetate and nitrate of lead—precipitated a salt of lead resolvable in excess of Acetate of lead but gradually separating in crystals. A quantity of the precipitate being obtained, it was washed in distilled water and then dissolved in boiling water; as the solution cooled the pure sulphocyanate of lead crystallised from it and on being washed again and dried was operated on.

The sulphocyanate of lead is very little soluble in cold water and not very much in hot water; it does not dissolve in alcohol but does dissolve in dilute Nitric acid; the solution is decomposed by sulphate of soda or sulphate of iron.

The dry salt heated in a tube fuzes whilst decomposing—a slight odour of Prussic acid and a little free sulphur—much sulphuret of carbon formed and a purplish fixed substance left looking like galena—but not affected like it by nitric acid. Nitric acid a little diluted acts on galena liberating sulphur readily, but with this powder, though it acted a little, no sulphur was liberated the whole remaining black and powdery: it contains lead and sulphur.

SULPHOCYANATE
OF LEAD, DECOM-
POSITION OF BY
HEAT.

A portion of gas was also liberated during the action which was almost entirely absorbed by solution of potash.

April 8. The above account of the residum incorrect. Nitric acid with a little water acts powerfully, leaving a residum which on evaporation and heating deflagrated as if a combustible and a nitrate were present. A portion powdered and heated with chlorate of potash burnt with powerful white flame like sulphuret of antimony.

Galena when similarly powdered and treated burnt far less powerfully with chlorate of potash, and with nitric acid gave a mixed white substance which when heated did not deflagrate, but a little sulphur burnt off and sulphate of lead left.

The residum above when heated in air burns as if carbon present, and leave[s] a substance like heated galena and affected like it by Nitric acid.

Proto nitrate of mercury and sulpho cyanate of potash yield a precipitate which when well washed and dried and heated in close vessels at first fused, then suddenly was decomposed yielding a vapour (green sulet. carbon), no permanent gas and leaving a bulky yellowish grey looking cinnaber.

SULPHO CY.
MERCURY.

1824. APRIL 8TH.

Sulphocyanate of lead (crystallised) heated in close vessels as before, residum free sulphur a little and sulphuret of carbon as before—the gas evolved collected over mercury—contained much vapour of sulphuret of carbon—odour that of sulphuret of carbon and a little prussic—combustible flame reddish blue producing strong smell of sulphurous acid—lime water dissolved about five sixths of the gas and became a little turbid but not as with carbonic acid—turbid, yellowish and probably some reaction—the small

DECOMPOSITION OF
SULPHOCYANATE
OF LEAD BY HEAT.
GAS EVOLVED, ETC.

DECOMPOSITION OF
SULPHOCYANATE
OF LEAD BY HEAT.
GAS EVOLVED, ETC.

portion left still combustible producing fumes of sulphur. The whole gas remained some time over mercury without any change, but a portion into which a little piece of paper had been put to absorb the sulphuret of carbon became brown after 24 hours; diminished to about one half in bulk leaving...

? Is the gas a mixture of cyanogen and vapour of sulphuret of carbon?

A portion of the gas over mercury with a piece of paper introduced to absorb the sulphuret of carbon, after standing 24 or 30 hours had diminished very much, above one half—the residue had a sharp pungent smell not like cyanogen or sulphuret of carbon—it was partly soluble in water and it burnt with a pale blue flame, producing a strong smell resembling sulphurous acid gas.

SUB SULPHO CY-
ANATE OF LEAD?

In purifying the Sulphocyanate of lead when precipitated by solution in water and crystallisation a portion of an insoluble salt was left. A portion of it dried at 212° when heated in a tube evolved very much ammonia and water and left a black powder, which in nitric acid was rapidly acted upon and a white powder produced. The solution contained no sulphuric acid but the white powder was a mixture of sulphur and sulphate of lead.

The body contains Lead, sulphur, oxygen, hydrogen, nitrogen, carbon?

APRIL 22ND.

SUL. CY. LEAD.

Crystd. sulphocyanate of lead when heated—the fumes acid to litmus and containing much sulphocyanic acid—tinging per sul. iron very deep red—gas liberated almost certainly cyanogen.

SUL. CY. COPPER.

Some salt of copper prepared—(Proto sulphocyanate of copper) heated: products like those from lead—fumes acid precipitating salt of iron red—charcoal in the sulphuret left, etc. etc.

Much sulpho-cyanic acid in the sulphuret of carbon formed on distillation; a drop of per sul. iron added produced strong precipitate.

1824. MARCH 25TH.

SULPHUR AND SUL-
LEAD.

Sulphur and Sulphate of lead powdered, mixed and heated evolve sulphurous acid gas and leave a dark brown substance which heated in air becomes white and very fusible; ? what is it.

Cyanogen formed and a little sulphuret of carbon passed up into it over mercury—bulk expanded about a fifth or sixth—admitted a piece of paper to absorb the fluid sulphuret of carbon. A portion of this mixture burnt in a tube gave strong odour of sulphurous acid like *the gas*.

MIXTURE OF
CYANOGEN AND
SULPHURET OF
CARBON.

A portion of this mixture was set aside with a piece of paper over mercury.

A portion had water admitted which absorbed the cyanogen; the solution was filtered and then heated in a tube over mercury; in this way the cyanogen was obtained probably free from the sulphuret of carbon but the gas on burning gave a pale blueish flame and smelt of sulphurous acid gas.

Oil was admitted to a portion; it appeared to absorb much of the gas but at last the action ceased. It was left all night.

1824. APRIL 22.

Sulphocyanate of lead and strong sulphuric acid *cold*—slow action, sulphate of lead formed—red tinging acid in the liquor on addition of a little water or heat—portion of sulphurous acid gas rose and the fumes though colourless tinged white cartridge paper of a rose tint—with persulphate of iron deep red colour—on distilling tinging acid rose—sulphurous acid and ultimately pure solid sulphur separated.

SULPHO. CY. LEAD
AND SUL. ACID.

Sulphocyanate of copper (the white salt) by heat in tube discoloration—darkening—no fusion or sudden action—suls. acid gas evolved—acid vapour reddening salt of iron—heat discontinued—mass thrown into water gave solution per sulphate copper and a greenish insoluble substance, heavy—contained sulphur, carbon and copper.

SUL. CY. COPPER BY
HEAT—BY S. A.—BY
N. A.

Cold Sulphuric acid either strong or diluted does not act on this salt; solution filtered has no effect on salt of iron and the copper salt remains unchanged—a drop of nitric acid caused immediate change—fumes of nitrous acid gas—sulphurous acid gas and I think hydrocyanic acid. They affect per sul. iron very little—much gas liberated and colour of mixture fine deep lilac—on adding water immediately became dull yellow and gave a blue solution of sul. copper leaving a mixture of sulphur and apparently the unchanged copper salt.

FINITE EXPANSI-
BILITY OF VAPOUR
—CAMPHOR,
IODINE.

Some tubes about $\frac{3}{4}$ of an inch in diameter and 4 inches long were slightly bent in the middle and then on having different substances introduced were exhausted of air by a good air pump and hermetically sealed so that the substance within was in vacuo. When all the substance had been collected in one extremity the other was covered by a piece of bibulous paper and connected by a thread with a basin of water, so as to be preserved constantly moist and consequently cooled by the evaporation.* Two tubes were thus arranged, one containing iodine, the other camphor. They were placed at 7 o'clk. in the evening in rather a dark place; the temperature of the air of the place was 56° but a thermometer moistened by paper, as the tubes were, stood at 53° . In this state they were left.

April 29th. At 3 o'clk. P.M. the Camphor tube had beautiful crystals in it at the place covered by the moistened paper. Temperature of thermometer 55° and 58° . The iodine tube contained no visible crystals at 5 o'clk. in the cooled part. Left as before.

1824. MAY 5TH.

—IODINE, MER-
CURY.

Iodine tube examined—now two or three considerably sized crystals in the cooled part, very solid and compact—there was no iodine in any other part but where these crystals were placed—left still longer that the crystals might enlarge.

A jar had some clean mercury put into it; a piece of tube closed at one end was thrust through a cork, a little piece of gold leaf stuck on to the end of the tube and the cork being placed in the mouth of the jar, the tube was depressed until the Gold leaf was very near the surface of the mercury, about $\frac{1}{8}$ of an inch off. Another piece of gold leaf on a similar tube was put into a jar containing no mercury for a point of comparison. This was done about a week ago. At present the gold leaf over mercury has a whiter appearance than that in the jar without mercury. Left for the effect to increase. *See next page.*¹

1824. APRIL 28TH.

—SULPHUR.

Some silver capsules were cleaned—a piece of roll sulphur was put into one of them and a little heap of flour sulphur on to another

¹ April 28th, p. 133.

*



part of the same capsule; the whole was put into a finger basin and covered over with a glass dish.

FINITE EXPANSI-
BILITY OF VAPOUR
—SULPHUR.

A small capsule without sulphur was put into a glass and also covered.

Another capsule was left without sulphur but exposed to the air.

And a fourth was exposed to the air but with a piece of sulphur in it.

All put into a dark place at 8 o'clk. in the evening and left. Temperature 56° .

April 29th. All the capsules containing sulphur stained, those with flour sulphur more than those with roll sulphur. Those without sulphur not changed in colour. The stains were merely on the spots where the sulphur lay and did not extend to any distance beyond it.

1824. APRIL 28TH.

Some clean Mercury put into a jar, the mouth closed by a cork from which descended a tube having a small piece of gold leaf on it, the gold leaf brought within $\frac{1}{4}$ inch of the surface of the mercury. Put in the same place with the other experiments, 8 o'clk. evening. Temp. 56° . *See previous page.*¹

—MERCURY,
IODINE.

April 29th. No decided change of colour in the gold as yet.

June 12th. Gold leaf decidedly whitened by the vapour of the mercury.

APRIL 28TH.

Iodine in a tube open to the air except by a cork. Polished silver wire introduced tarnishes instantly and if put within half an inch of the iodine deeply tarnished. Temp. 56° .

1824. APRIL 29TH.

Camphor in the bottom of a clean tube, a smaller tube put down to it and then air inhaled by the nostrils placed close to the upper end of the inner tube; strong smell of camphor. The Camphor and tube then cooled down by an artificial mixture to -10° F. and the nostrils applied as before; a smell of camphor could still be perceived but it was very faint indeed.

—CAMPHOR,
IODINE.

¹ May 5th, p. 132.

FINITE EXPANSI-
BILITY OF VAPOUR
—CAMPHOR,
IODINE.

A similar tube had some dry iodine introduced into it and the atmosphere above it tested by a silver wire as yesterday (temp. 56°). This tube also cooled down to -10° F. and the silver wire introduced; when placed almost in contact with the iodine it became but very slightly tarnished in half an hour and the smell tried by a smaller tube as with the camphor could scarcely be perceived—must have been a very weak vapour indeed but evidently there was a vapour.

1824. MAY 14TH.

CYANURET OF
MERCURY AND
SULPHUR.

Cyanuret of mercury pulverised, dried and mixed with sulphur—put into a tube and heated—blackened much, gas liberated and received over mercury—a little fluid like sulphuret of carbon in appearance also formed—substance left nearly black—burnt on platinum as if containing a little carbon—sulphur and mercury in close vessels heated, cinnabar sublimed and reddish powder left which at a higher temperature on platinum fused and ultimately evaporated. Some sulphur rose with the gas and lined the tube, also apparently a portion of sulphuret of mercury.

Water agitated with a portion of the gas absorbed about one half and gave a red tint with per sulphate of iron—the unwashed gas burnt like a mixture of cyanogen and sulphuret of carbon—the washed gas after standing some time over water left a residum which in a tube burnt with a pale blue flame, passing through it as if it were a mixture of a little inflammable gas and some common air.

Another portion of dry cyanuret of mercury was mixed with a small proportion of sulphur, put into a tube and heat applied slowly to the upper part of the mixture—in a few moments there was action, further heat was produced which was sufficient to propagate the effect gradually from the top to the bottom of the mixture—no sulphuret of carbon was formed, but gas came over the whole time which was combustible—entirely absorbed by water and had all the properties of pure cyanogen—hence sulphur not in excess seems merely to displace cyanogen from mercury.

CYANOGEN OVER
SULPHURET OF
POTASH.

Sulphuret of potash or potassium formed by fusing carbonate of potash with excess of sulphur a dark red compound—a portion of this heated to redness in a green glass tube till dry—then intro-

duced into another green glass tube and being heated to redness cyanogen sent over it; the gas was absorbed with considerable rapidity and what little passed over into the mercurial trough was pure cyanogen—a little sulphur was separated—all the sulphuret was not acted upon but where the action had been complete the compound became white or yellowish on cooling and on examination proved to be nearly pure sulphocyanate of potash.

CYANOGEN OVER
SULPHURET OF
POTASH.

Some sulpho cyanate of potash fused and dried, then put into a green glass tube and heated; at first a little sulphur rose (from the air in the tube acting perhaps) but afterwards no further change of that kind—when dull red or scarcely visibly hot the tint a deep blue which disappeared on cooling and gave place to a buff colour—by further heat the blue tint disappeared—it was ultimately heated by blow pipe to whiteness but there was no alteration in the substance or action on the glass—on cooling it crystallised, was of a yellowish colour—was deliquescent as before—and on solution though very slightly alkaline was otherwise just as it was before being heated.

SULPHOCYANATE
OF POTASH
BY HEAT.

10 grs. of the dry crystallised sulphocyanate of lead were pulverised and mixed with 150 grs. of per oxide of copper, put into a green glass tube with asbestos, etc., and heated by Cooper's lamp. 8.5 c : i: of gas were obtained, but a little escaped; of this $\frac{2}{3}$ were carbonic acid gas and $\frac{1}{3}$ was nitrogen—the asbestos contained a little water, about $\frac{1}{10}$ of a grain (perhaps by absorption, for after the tube had been packed it lay aside for 3 or 4 days).

SULPHOCYANATE
OF LEAD ANALYSED
BY OXIDE OF
COPPER.

2.833 c : i: nitrogen = .84333 of gr. Nitrogen.

5.666 c : i: carb. acid = .71826 of gr. carbon.

The substance left in the tube when boiled with a little water gave solution of per sulphate of copper—another portion digested with nitric acid gave at first whitish appearance as of sulphate of lead but the whole ultimately dissolved in the excess of nitric acid and when diluted precipitated with muriate of baryta and with sulphate of soda or with nitrate of lead. It contained therefore Sulphuric acid and lead and apparently no sulphuret of lead or copper.

Bottle of water from Mr. Reynolds Solly. The water was obtained in the late expedition by dissolving a portion of the ice

WATER FROM SEA
ICE.

WATER FROM SEA
ICE.

in Winter Harbour in the late Northern expedition. When procured the ice though not salt had a very peculiar taste. The harbour was frozen over with ice 6 feet thick and throughout the whole not the least appearance of containing salt. The water was from ice taken at the centre part of the harbour, about 3 feet below the surface. It was brought home by Mr. W. Griffiths.

On examination the water was found to have a pleasant taste, not at all brackish. It contained Muriatic acid, Sulphuric acid, a little magnesia but no lime.

1824. MAY 15TH.

ANALYSIS OF
SULPHO CYANATE
OF LEAD.

Dry sulphocyanate of lead in diluted nitric acid pure—on applying gentle heat strong action and effervescence—the capsule ultimately contained sulphate of lead and also plenty of free sulphuric acid. The gas collected was not soluble in water, at least to a very small extent, and was almost pure nitric oxide. Query the state of the Carbon.

45 grs. of the dried salt of lead in diluted nitric acid—with heat sudden and violent action in the flask but I believe no loss except in vapour; boiled and left till monday.

MAY 18TH.

Sulphate of lead washed, dried, etc., by sand bath = 42·8 gr. —a portion heated gave off a little water and nitrous acid; 30 gr. therefore heated with sulphuric acid and water left 29·4 gr. sulphate of lead; hence the 42·8 gr. equalled 41·944 gr. dry sulphate of lead.

The solution before the separation of the sulphate of lead had been neutralised by ammonia. It was now acidified by pure nitric acid and precipitated by muriate of baryta; 32·4 gr. of pure dry sulphate of baryta were obtained.

100 grs. therefore of the sulphocyanate of lead yielded by this experiment

Lead . . . 63·77 from the 93·21 sulphate of lead.

Sulphur . . . 19·574 { 9·81 from Do. Do.

{ 9·764 from the 72 of sulphate of baryta.

By the former experiment

Nitrogen . . . 8.4333 from the 28.33 c: i: of nitrogen.
Carbon . . . 7.1826 from the 56.66 c: i: of carbonic acid.

98.9599

Lead	104	.	.	.	1 atom
Sulphur	31.92	.	.	.	2 atoms
Nitg.	13.75	.	.	.	1 atom
Carbon	11.7	.	.	.	2 atoms

Metallic zinc put into water with Sulphocyanide of lead precipitates the lead metallic and forms a sulphocyanate of zinc.

1824. MAY 25TH.

Sulphuret of Potassium formed by passing hydrogen over sulphate of Potash at red heat in green glass tube—ultimately a sulphuret formed which when hot was liquid and of a deep brown colour; but when cold, light red colour and solid—tube closed and allowed to cool.

ANALYSIS OF
SULPHO CYANATE
OF LEAD.

CYANOGEN OVER
SULPHURET OF
POTASSIUM.

Dry cyanogen passed over this sulphuret; immediate action even when cold, absorption of cyanogen and a blackening of the substance—application of heat increased the effect—the tube became black beyond the sulphuret of potassium—after some time the process stopped—the gas which had passed through had been received over mercury; it was almost pure cyanogen—about $\frac{1}{10}$ unabsorbed by water and that burnt with a blue flame like carbonic oxide. Examined by detonation it proved to be Carbonic oxide (not entirely, but about $\frac{2}{3}$, the rest being nitrogen). It resulted probably from the action of the cyanogen at the high temperature on a portion of undecomposed *sulphate* of potash mixed with the sulphuret of potassium.

The tube opened. The black substance near the end burnt entirely away like charcoal—it slowly coloured cold water and water gave faint indications of sulphocyanic acid to salt of Iron—boiled, the water rapidly became of a deep brown colour, but it caused no redness with salt of iron nor any precipitate with acetate of lead—the insoluble part heated gave ammonia and sulphuretted hydrogen with a smell of prussic acid—the soluble portion as above the same.

CYANOGEN OVER
SULPHURET OF
POTASSIUM.

The substance itself or altered sulphuret of potassium was black—deliquescent—slightly alkaline—taste like nitre or sulphocyanate of potash—its solution in water deep brown, precipitating sul. iron deep red—with acetate of lead a sulphuric acid liberated no sulphuretted hydrogen but a strong odour as of hydrocyanic acid. Substance seems to be a mixture of sulphocyanate and cyanate of potash. Dissolved in water, filtered (deep brown), evaporated to dryness, put into a tube and heated red—much ammonia came off—black substance was destroyed and the remaining salt was easily fusible and unchanged by the heat; this dissolved in alcohol gave a perfectly clear solution, rather alkaline and containing cyanate of potash and sulphocyanate of potash.

1824. JUNE 14TH.

SULPHOCYANATE
OF COPPER WITH
AMMONIA, ACID,
ETC.

The proto sulphocyanate of copper put into liquid ammonia becomes blue (i.e. solution) but the whole if entirely soluble take a long time for the purpose—the solution neutralised by sulphuric acid deposits part of the white salt again unaltered and the solution contains sulphate of copper and sulphocyanic acid—ammonia therefore dissolves it and with access of air appears to decompose it, giving rise to formation of peroxide.

Diluted sulphuric acid on this cupreous salt dissolves a little but does not decompose it. Strong sulphuric acid appears to have a tendency to decompose it but with difficulty. On applying heat, decomposition with effervescence, per sulphate of copper formed and a brown powder left insoluble in sul. acid and which when washed, dried and heated in a tube gave a little sulphur, some sulphuret of carbon and left a black sulphuret of copper.

This looks as if the compound contained copper united to sulphocyanogen and not an oxide of copper united to an acid.

Moist hydrate of per oxide copper put into sulphocyanic acid dissolves and form[s] a blue solution of per sul. cyanate of copper, but on standing over excess of oxide and especially by boiling on it the whole becomes proto sulphocyanide of copper and precipitates, whilst the liquid contains neither Sul. cy. acid nor copper. An acid (S. A.) by dissolving the excess of oxide leaves the white insoluble S. Cy. Copp.

Crystallised sulpho cyanate of lead pulverised and digested with ammonia in excess readily decomposes it in part, producing apparently a sub sulphocyanate of lead (to be further examined) and giving a solution which when evaporated carefully and considerably becomes solid on cooling. This substance is then very fusible—very deliquescent—very soluble in water and alcohol—solutions neutral—and giving the usual tint with per salts of iron—taste saline, something resembling nitre. By heat in a tube it first fuses, sul. hydrogen and ammonia fly off, also a portion of a fluid apparently sulphuret of carbon, and a part of the salt sublimes in brilliant transparent drops; either this or the original portion by higher heat is decomposed with ebullition and a charry stain left.

SULPHOCYANATE
OF AMMONIA FROM
SALT OF LEAD.

By repeated boilings of ammonia on the same salt (removing a little sulpho cyanic acid each time) it became at last heavy and buff coloured—this with Sul. acid and salt of iron still gave signs of sulpho cyanic compound—when dried and heated in a tube gave ammonia and very little tinging fumes and left black substance which by further heat gave yellow fused oxide of lead. No sulrt. of carbon and no sulet. of lead except what the oxide might dissolve. The buff coloured substance quite soluble in N. A. when diluted and a little heat—carb. acid evolved—a little redness as of sul. cy. iron—the solution left no sulphur undissolved and contained no sulphuric acid. Hence substance nearly pure oxide or carb. of lead.

Sulphocyanate of lead pulverised and warmed in a capsule with solution of baryta, the latter being added in successive portions until the whole remained alkaline: then filtered—the residuum when washed appeared to be a sub compound of lead like that left by the ammonia on addition of sulphuric acid, and sol. of iron gave abundant red colour. Some of the same residuum digested with carbonate of potash was entirely decomposed, only carbonate of lead remaining. Solution of pure potash on the contrary dissolved the whole—perhaps had first decomposed it.

SUB-SUL. CY. OF
LEAD.

The barytic solution was filtered and a current of carbonic acid passed through it until it was neutral; it was then again filtered and on examination proved to be a neutral sulphocyanate of baryta. On evaporation it crystallised—by warmth effloresced and when cold deliquesced.

SULPHOCYANATE
OF BARYTA—FROM
SALT OF LEAD.

SULPHOCYANATE
OF BARYTA—FROM
SALT OF LEAD.

The barytic salt heated on platinum foil effervesced and then burnt, giving sulphurous fumes and leaving an alkaline residuum. Heated in a close tube gave at first water—this accompanied with ammonia and a little sul. hydrogen—the salt then fused and became dark coloured and bore a bright red heat without change. When tube opened the greyish white substance left was soluble in water and rather alkaline, but contained sulphocyanate of baryta unchanged—hence first results probably from presence of water. Carbonic acid was again passed through the salt in solution and the whole rendered neutral, filtered and evaporated. This heated in a tube as before gave much ammonia with water, a little sulphuretted hydrogen and after a red heat, being dissolved, was found as before an alkaline sulphocyanate of baryta. On passing carbonic acid through it there was a strong smell of sulphuretted hydrogen, suspected to be from the presence of hydro sulphuret of baryta; the whole therefore being rendered neutral was heated and filtered and a solution of the salt obtained which when tested contained no sulphuretted hydrogen and gave white precipitate with lead. This evaporated to dryness and heated in tube as before gave water and abundance of ammonia and after fusion and solution the salt contained hydrosulphuret of baryta—no sul. hydrogen or very little came off with the ammonia.

SUL. CY. POTASH BY
HEAT WHEN MOIST.

After this a small portion of sulpho cyanate of potash, rather moist, was heated in a large tube so that the vapour of the water should be in contact with the substance; there was partial decomposition, ammonia and sul. hydrogen came off, the salt became slightly alkaline and contained afterwards a little hydrosulphuret of potash. This effect evidently due to the water present.

The sulphocyanate heated on platina foil in the air became slightly alkaline and a sulphate of potash left.

JUNE 10TH, 1824.

COMPATIBILITY OF
SUL. LIME AND
CARB. SODA.

A weak solution of sulphate of lime and bicarbonate of soda boiled becomes alkaline but still sulphate of lime remains in solution. If evaporated to dryness and then washed or dissolved in water sulphate of lime is still taken up.

Such an alkaline (carbonate) solution is but very slightly affected by lime water; the lime will hardly test the carbonic acid present.

Ferro Prussiate of potash and Phosphorus heated together in a tube but no change took place—no formation of anything like the sulpho cyanate. FERRO PRUSS. POT.
AND PHOSPHORUS.

Pyrophorus of lead dropped into chlorine burns brightly but residue black, etc. GOBEL'S PYRO-
PHORUS WITH
CHLORINE.

Some of the Pyrophorus made in a tube and then a stream of chlorine passed over it—when the chlorine passed rapidly the mass ignited, when more slowly it heated only without ignition; at those time[s] a portion of fluid passed into the farther end of the tube looking like protochloride of carbon, and the gas which issued from the end of the [tube] evidently by the odour contained chloride of carbon, but it was in small quantity only. The substance in the tube was black and when boiled in water gave a solution of chloride of lead and left charcoal very nearly pure; it was light and very finely divided; there was a considerable proportion of the black charcoal so that very little had combined with the chlorine.

The pyrophorus easily moistens and sinks readily in water—appears of a deep blue or brown according as it is more or less burnt in the preparation. Taken out of the water and dried it will not inflame in the air at common temperatures but does when the temp. is about perhaps 250°. The water dissolves nothing.

Pyrophorus in water, iodine put to it—action took place, the whole left for two days—then washed; the washing on evaporation gave little iodine and crystals of iodide of lead, nothing else. The solid matter pressed, dried and heated in tube gave first iodine, then water, then a little sublimate of iodide of lead and left iodide (and charcoal) behind. The whole was black.

Pyrophorus in Alcohol—nothing dissolved out—iodine added—heat evolved, colour changed and alcohol became colourless—added more iodine until in excess—more heat—the mass became of a yellow grey colour, rather light in tint—whole left till monday. On Monday alcohol separated and substance washed till all iodine removed—alcohol contained iodine, a little iodide of lead and a trace of some other substance, but nothing marked. The residum was yellow grey substance like that from water and acting like it in tube when heated.

A portion of the substance either from alcohol or water heated

- GOBEL'S PYROPHORUS WITH CHLORINE. on platina foil: volatile with fumes like iodide of lead. Another portion boiled in repeated waters gave solution of iodide of lead and left a black substance almost all charcoal—a little iodide or lead in it.
- A portion in Ether underwent no change.
- FER. PRUSS. POT. AND SULPHUR. On heating Ferroproussiate of potash and sulphur together for preparation of sulphocyanate of potash—constant liberation or sulphuret of carbon.

1824. JUNE 21.

- GOBEL'S PYROPHORUS WITH IODINE. A portion of the substance from water and iodine described in the last page¹ was treated with solution of Alkali; it became black, then it was washed and N. Acid added to dissolve oxide of lead; on washing again a black powder left which was almost entirely charcoal.
- A portion of the substance heated with Mur. acid became grey and on washing with water Muriate of lead was dissolved out and charcoal left. When cold the action was much slower.
- Do. with Nitric acid—Nitrous gas evolved—nitrate of lead formed and a mere mixture of carbon and iodine left.
- Do. with sulphuric acid—the action just as if on iodide of lead and charcoal mixed.

1824. JUNE 22ND.

- TART. LEAD AND IODINE. Tartrate of lead and Iodine mixed in a mortar—then heated in a tube; iodine rose and salt decomposed but no results except iodine, iodide of lead and charcoal with the usual gases.
- TART. LEAD AND CHLORINE. Tartrate of lead in retort with chlorine gas: no immediate change—put in sun light still no change: left for the morrow. Then heated (as no change had taken place); the chlorine disappeared, water was formed, muriatic acid and also chloride of carbon (fluid), for when water and potash were added strong odour of that substance. Effect however not very striking or important.
- GOBEL'S PYROPHORUS AND CHLORINE. Some of the pyrophorus put into water, then the mixture poured into a bottle of chlorine and the whole put into sun light and left till the morrow. On the morrow the pyrophorus was

¹ See June 19th, p. 141.

altogether brownish—on examination contained Muriate of lead and charcoal and no chloride of carbon—a little pyrophorus remained unchanged.

GOBEL'S PYROPHORUS AND CHLORINE.

1824. JUNE 23RD.

Fuzed Sulphocyanate of potash put into strong Sulphuric acid—no immediate action, but a little warmth caused powerful effect, much gas and vapour evolved smelling like sulphuretted hydrogen but yet acid and not like cyanogen or its compounds, and great heat was excited. A yellow substance was left in the acid which being collected, washed and dried appeared pulverulent and when heated in a tube gave water and other vapour with sulphur and left carbon. Boiled in Alcohol it communicated a yellow colour and the alcohol on evaporation left yellow substance which heated in a tube gave sulphur and carbon. Ether acted like Alcohol, substance not very soluble in either. The substance after being boiled in Alcohol and dried seemed much freer from water than before, and on being heated in a tube gave scarcely any thing but sulphur and carbon. It either seems to be or contains a solid sulphuret of carbon.

SULPHOCYANATE OF POTASH IN STRONG SULPHURIC ACID.

1824. JUNE 25TH.

Prepared Sulphocyanate of potash. Equal parts of prussiate of potash and flour sulphur—fused in florence flask in a sandpot. After solution a little pure potash added to make it alkaline—very little Iron precipitated—then filtered and added solution of sulphocyanic acid until solution was acid altogether—the sulphocyanic acid contained a little sulphuretted hydrogen—then evaporated the solution—it gradually became turbid depositing a substance like hydrated sulphur in appearance which on standing formed flocculi—this separated by filtration, the liquid concentrated and when solid set aside for experimental purposes.

PECULIAR SUBSTANCE FROM PREPARATION OF SULPHOCYANATE POTASH.

The precipitate washed, collected and examined. It is not soluble in water or Alcohol?—heated on platinum foil did not burn but by a red heat entirely volatilised. Heated in a tube gave water—much ammonia and salt of ammonia and yellowish substance remained which heated more highly gave a black empyreumatic product and was wholly volatile with smell of cyanic

PECULIAR SUB-
STANCE FROM PRE-
PARATION OF
SULPHOCYANATE
POTASH.

compound. It contains no lead—sulphuric acid and per salt of Iron indicate no sulphocyanic compound. Nitric acid heated on it effervesces and a little nitrous gas is formed—the whole of the substance is dissolved but on cooling or by dilution again appears unaltered. The action seems due to impurity only: must be further examined (by oxide Copper).

iodo sulpho
cyanate of
potash.

Dry or at least fused sulphocyanate of potash in a tube—the salt melted and iodine passed over it—immediate action and apparent evolution of some gas or vapour—salt became much less fusible and ultimately very difficult to fuse—some parts seemed to absorb double proportion of iodine, for they became black and more fusible, and when heated gave off Iodine, became grey and less fusible—there was iodine in excess and ultimately the salt was fused together into the bottom of the tube—the vapour liberated affected salts of iron like sulphochyazic acid, but there was very little of it and that perhaps formed by water—some sulphur was set free and sublimed—the salt broken out it tasted like sulphocyanate of potash and was deliquescent—its solution was quite neutral—a little residum was left, apparently impurity from Ure's Iodine. The solution precipitates nitrate of lead yellow like iodide of lead and per sul. iron coloured red like sulpho cyanate. After being precipitated by Nit. lead and the iodide? separated the solution then affects salts of iron very strongly. Strong Sul. acid liberates iodine from the salt or solution. The solution filtered, evaporated, put in a tube and heated behaved exactly like sulpho cyanate of potash, giving at first a little ammonia and then bearing a red heat unchanged. On re-solution was just as before.

Is one of sulphur replaced by one of iodine here? There was iodine in excess.

JUNE 28TH.

Some iodine put into solution of sulpho cyanate of potash in water—first portions of Iodine dissolve and their colour disappears—no precipitation of sulphur—more iodine added until solution of a deep colour and iodine remaining undissolved—poured off the solution, put it into a flask and boiled it; excess of Iodine gradually dissipated, no precipitation of sulphur, filtered—solution yellow with nit. lead and red to per sul. iron,

indeed exactly like that prepared in the dry way—solution contained a little sulphuric acid but not more than the original sulpho cyanate of potash—evaporated to dryness was very deliquescent, etc.

The yellow precipitate by lead looked like iodide of lead—abundance of water dissolved it—solution filtered was colourless—concentrated—when pretty strong and a film began to form was taken off to cool; shortly crystals like flocculi formed through the whole mass and the solution from being colourless became almost a solid yellow body. This not quite like iodide of lead (examine the substance).

See next page but one.¹

Packed up in a crucible for Mr. Christie 1000 steel + 60 pure nickel. Fusion July 4th. Crucible and all right—when opened fusion good but upper surface of the button very convex and again lower surface very cavernous. When all liquid must I think have been compact but on cooling perhaps gas has been evolved which has thrown it into that form.

STEEL AND NICKEL.



Preparation of Sulpho cyanic acid. Sulphocyanate of potash and diluted sul. acid distilled in a retort—have distilled to dryness. Residuum in retort smelt of sulphuret of Carbon—is solid, white and crystalline, saline and acid—water added and solution filtered—small insoluble portion proved to be sulphur.

PREPARATION OF
SULPHO CYANIC
ACID.

Solution with per salt of Iron neither red nor blue—solution was yellowish, turbid rather and acid—evaporated until so far concentrated that on cooling crystals were deposited—these were then left to drain.

These crystals when heated gave very evident smell of sulphur, then ammonia and left sulphate of potash—when heated in tube same results but no deposit of sulphur—treated with potash yielded abundance of ammonia. Is a salt of potash and ammonia, perhaps a sulphate—but smell of sulphur at first peculiar.

Solution further evaporated gave a second similar crop of crystals. The crystals with S. A. evolve no suls. acid, hence no sulphite.

¹ July 1st, p. 146.

iodo sulpho
cyanate of
potash.

*From last page but one.*¹

The mass mixed up and filtered and then pressed between bibulous paper and dried—looked like iodide of lead but when heated in tube much ammonia rose, no sulphocyanic vapour, and fixed red fused iodide of lead remained. Some iodide of lead dissolved in water, filtered and evaporated until salt began to crystallize then set aside to cool gave very different appearance, the substance crystallizing gradually in plates and not in a mass as the other.

The solution of Iodo sulpho cyanate of potash obtained in the former part of this experiment—evaporated—the salt obtained was like the other by heat (dry)—heated in tube it gave ammonia—then sul. hydrogen—became green—then brown—bore a red heat and when cold and in solution was alkaline and contained sul. hydrogen in combination with part of the potash, but still it was a sulpho cyanate and contained iodine, hence analogous in effect to salt without iodine.

Solution with Nitrate of silver gave a precipitate of which part at least was an iodide of silver as it would not (all) dissolve in ammonia.

chlorine on sul.
cy. potash.

Solution of sulpho cyanate of potash was put two days ago into a jar containing chlorine gas—absorption immediately and production of some heat—today solution poured out—it and the jar smell strongly of phosgene gas—solution boiled and filtered—very acid, contains abundance of sulphuric acid—no change with per sul. Iron—evaporated to dryness left an acid salt like acid sulphate of potash but heated with potash it yielded ammonia, hence probably an acid sulphate of potash and ammonia.

mur: acid gas
over dry sul.
cyanate of
potash.

Dry sulpho cyanate of potash in tube—heated and dried air passed over it to remove all possible moisture—then stream of M. A. G. first passed over mur. lime then over it—whilst cold no apparent action—when heated immediate effect—salt becomes more infusible, much effervescence and yellow sublimate. M. A. Gas absorbed, some that came over collected over mercury, some that escaped strong smell of sul. hydrogen and burnt like it but with purplish edged flame—fumed—dense fumes when whole of

¹ June 28th, p. 145.

tube heated—apparently of muriate of ammonia—the end of the tube which broke off contained muriate of ammonia and a little sulphur—a few drops of water let up into first portion of gas—absorbed nearly the whole of it producing a yellow brown deposit in the water and the small portion of gas which remained burnt like sulphuretted hydrogen. The solution when filtered was clear and colourless—acid—muriatic acid—deep red tint with sulphate of Iron—contained a little sulphuric acid.

MUR: ACID GAS
OVER DRY SUL.
CYANATE OF
POTASH.

1824. JULY 2.

Tube of yesterday examined—contained Mur. pot. Mur. ammonia—very little sulpho cyanate of potash—and an *insoluble substance* of an ochre yellow colour.

M. A. GAS OVER
DRY SUL. CY.
POTASH.

This substance on platina foil volatile or dissipated with commencement of fusion leaving at last a very minute trace of potash (impurity). In tube—ammonia, smell of cyanogen or prussic acid—empyreumatic black sublimate—yellow sublimate and little alkaline residuum.

Mur. acid on sol. of sul. cy. potash—strong vapour reddening per sul. iron—precipitation of salt perhaps mur. pot. and now and then slight effervescence but no smell of sul. hydrogen—but when heated in a tube reaction took place, sul. cyanic vapour—sul. hydrogen evolved and a yellow insoluble substance formed which on dilution with water was deposited—a yellow precipitate on dilution also from the cold portion but in smaller quantity—still strong odour of prussic acid from diluted portion.

M. ACID ON SOLU-
TION OF SUL. CY.
POT.

Yellow substance of yesterday—collected, washed and dried—on foil almost entirely volatile—in tube volatile—fluid rises first clear and colourless and at same time pungent sulphurous vapours and abundance of sulphocyanic acid, for it reddens salt of Iron astonishingly. Is this fluid or vapour pure dry sulpho cyanic acid?—then by heating fluid it becomes yellow, deposits sulphur, gives sulhydrogen and ammonia, hence very decomposable—the remaining part heated gives similar results and a yellowish stain is left which on breaking the tube and heating in the air disappears. No appearance of free carbon.

PECULIAR YELLOW
SUBSTANCE.

PECULIAR YELLOW
SUBSTANCE.

Substance contains Sulphur
Nitrogen
Hydrogen
Carbon?
Water?

Send it over oxide of copper.

Yellow substance—water boiled on it becomes of a yellow euchlorine colour—substance not affected by that heat—no tint with sul. iron or nit. lead—hence no sul. cy. acid or sul. hydrogen formed—sol. evaporated on glass plate, substance deposited in crystals.

Alcohol by boiling dissolves a small quantity forming a yellow solution—filtered and evaporated either in basin or on glass plate gave substance in crystals.

Ether also dissolves it by boiling and on evaporation yields the crystals. None of these solutions affect salts of Iron.

Sol. Ammonia added to a portion—made colour paler and suspended it in the liquid—no sul. hy. formed in ammonia—on boiling became transparent and yellow—a drop on glass?

The rest made acid by M. A. and tested by per sul. iron gave red tint.

Sol. Potash exactly like ammonia.

July 6th. Some of the yellow substance put into strong N. A.—soon spontaneous action, liberation of Nitrous gas and solution of every thing—on testing found sulphuric acid had been formed—Mur. acid appears merely to dissolve it—for on evaporation on a glass plate the yellow solution yields the yellow crystals.

Some of the substance crystallised by spontaneous evaporation of an alcoholic solution was beautifully in curved dendritic forms so as to look like vegetation or like some corals—the appearance in the Microscope beautiful.

1824. JULY 2.

MUR. ACID ON SUL.
CY. POTASH.

Crystd. Sul. cy. pot. in tube, little M. A., at first turbid then clear and cold from solution of the salt—strong vapour of sul. cy. acid rose; added a little more acid and salt, acid in excess—became turbid—still much vapour of sul. cy. acid—warmed, a little became solid and hot—heating of itself—effervescence—very much vapour

and formation of yellow insoluble substance—heated a little, very much vapour flowing over—smelling like pungent cyanic acid—inflammable, very pale flame and producing sul. acid among other things. Boiled some time, diluted a little, poured off clear liquor which was yellow—added a little M. A. and evaporated in a capsule to dryness carefully—was yellow but on solution and filtration the yellow matter deposited on filter—was like the other portions of yellow substance—solution gave no red with sul. iron but on evap. and heating with potash gave much ammonia. Hence Ammonia formed by action of M. A. on sul. cy. pot.—the yellow colour due to solution of yellow substance.

MUR. ACID ON SUL.
CY. POTASH.

Some Sul. cy. pot. with small quantity of M. A. distilled in a tube retort—heated by a water bath to 212° —very little gas came over—no sul. hydrogen—gas slightly combustible producing sulphurous acid—smells of cyanogen—water absorbs some of the gas, the solution gave no precipitate with salt of lead or colour with salt of Iron. A little sol. of potash let up to another portion—only a little gas absorbed—the gas left smells of cyanogen but contains sulphur—the solution with lead gray, not brown or black—with iron (per sul.) dark greenish precipitate sol. in M. A. No sul. cyanic acid and no sul. hydrogen.

More acid added to the salt or yellow substance and reheated—gas more abundantly—combustible with smell of sulphurous acid (that after being washed in water). Query the nature of this gas.

1824. JULY 5TH.

Sulphocyanate of ammonia—made from salt of lead by ammonia—heated in tube effects as on June 14th—ammonia—a little sulpho cyanic vapour—sul. hydrogen, etc. etc.

SULPHURIC ACID ON
SUL. CYANATE OF
AMMONIA.

Some salt with sulphuric acid strong—spontaneous action, production of heat and effervescence—vapours very highly sul. cyanic—ammonia held near produced fumes—smell cyanic—inflammable, pale flame, results highly sulphurous—on heating, more vapour—no sul. hydrogen formed, at least acetate of lead not browned by the vapour but whitened from formation of sul. cy. lead—salt Iron very red as before.

Some sul. cy. amm. and strong sul. acid distilled in a little retort and gas collected in successive portions—heat gradually

SULPHURIC ACID ON
SUL. CYANATE OF
AMMONIA.

applied to the retort at first 160° then 212° , etc., at last a lamp heat—at first formation of yellow substance and thickening of the mixture—boiling over, etc.—ultimately mixture became thinner when lamp applied and gas more freely but then probably a different gas.

July 6th. First portion of gas examined—little water absorbs a small portion of the gas but the solution gave no red with per sul. iron—much water absorbs nearly the whole of the gas—the gas smells strong and pungent like sulphurous acid and a little cyanogen—when mixed with air feebly combustible and then smells far more of sulphurous acid—no sul. hydrogen in the gas. Solution of potash added to some of the gas absorbed about $\frac{3}{4}$ of it—the residum left contained sul. hydrogen and was nearly all soluble in water—the solution of potash also now contained sul. hydrogen in abundance. It had been formed by the action of the potash.

Last portions of gas—almost entirely absorbed by water—no sul. cyanic acid—little remainder inflammable with pale flame—the gas smells strongly of suls. acid gas even when half absorbed by water—no sul. hydrogen at present. To a portion of the gas added solution of potash—only about half the gas absorbed even by agitation though potash in great excess—the solution became black and dirty. The gas remaining was now less soluble in water—had a slight odour and contained sul. hydrogen—it was more combustible than any other portion of gas previously obtained by washing, etc., and when burnt gave a pale blue flame producing *strong fumes* of suls. acid gas. This gas again treated with potash and water—at last a portion obtained insoluble—little smell but combustible producing sulphurous fumes.

The Alkaline solution brown black with acetate lead—greenish black with per sul. iron—sul. acid liberated abundance of sulphurous acid vapours—hence contained suls. acid and sul. hydrogen.

The sulphuric acid in the tube contained very little of the yellow substance, it having boiled over or decomposed.

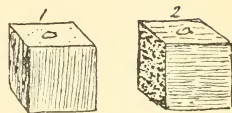
1824. JULY 5TH.

CONDUCTION OF
HEAT BY CRYSTAL-
LINE BODIES.

Two cubes (roughly made) cut out of a mass of artificial striated sulphuret of antimony so that the directions of the

crystals should be parallel to 4 of the sides and perpendicular to the other two. They were about an inch in the side—a piece of pomatum was put on the top of each and they were then placed on a surface of copper heated by boiling water beneath, the positions of the cubes as to the direction of the crystals being as in fig. 1 and 2. In the course of a short time pomatum on fig. 1 melted, but it required full four times as long a period before that on 2 melted—pieces of wax placed on each: that on 1 softened after some time but did not melt; that on fig. 2 did not experience any thing like the change. The surfaces on which the pomatum and wax had been applied were then put in contact with the cheek and upper lip and fig. 1 felt by far the warmest. Even on applying the surfaces which are lowest in the figures and which were almost certainly at the same temperature, still fig. 1 felt much hotter than fig. 2.

CONDUCTION OF
HEAT BY CRYSTAL-
LINE BODIES.



Sept. 17th. Tried the same experiment with cubes of fibrous iron but could perceive no difference occasioned by direction of fibres. Tried also with plates of carbonate of lime, some cut perpendicular to the axis of the rhomboid others parallel to it, but could again find no difference. Hence effects above probably due to want of contact of the fibres latterally.

1824. JULY 6TH.

Sulpho cyanate of lead in Mur. acid—cold—fumes of sul. cy. acid rose—after a while turbidness and decomposition with pro-
duction of yellow substance just as with salt of potash.

SUL. CY. LEAD IN
M. A.

Peculiar yellow substance perhaps best formed by adding to a saturated solution of sul. cy. potash about as much or rather more of strong pure Mur. acid, boiling carefully for about five minutes, then cooling, diluting and washing, etc. etc.

PECULIAR YELLOW
SUBSTANCE.

Sept. 20th. Boiled in oil becomes dark coloured and is apparently decomposed. Heated with mercury—sulrt. of mercury is formed and a vapour rises, combustible and tinging sul. iron red.

Heated alone in tube gave much sulrt. carbon—ammonia—sul. hydrogen—and vapours were combustible and reddened per sul. iron. Sulphur also rose and a yellow substance remained fixed at moderate temperatures, but at higher heats entirely disappearing. This substance heated in small tube highly gave odour

PECULIAR YELLOW
SUBSTANCE.

of prussic acid—plenty of ammonia and a charring stainpart—at the same time subliming undecomposed. It does not seem to contain sulphur but must contain Carbon, Nitrogen and hydrogen. It is insoluble in water and not readily acted on by N. M. Acid.

RED SULPHO
CYANATE OF IRON.

[July 6th.] Per sulphate of Iron precipitated by great excess of soda, boiled with it and well washed in many waters; then filtered and pressed but preserved moist. Some of this peroxide put into solution of sulphocyanic acid—immediate action and a deep red solution formed which after being heated and left for 12 hours was experimented with.

Solution of sulpho cyanate of Iron evaporated on a warm glass plate left deep red mass—crystalline?—which was resolvable either in water, Alcohol or Ether but not in oil of turpentine or in olive oil. It was deliquescent at common temperatures. Its taste was chalybeate.

Alkalies, either potash, soda or ammonia threw down from it hydrated protoxide of Iron.

Its colour was destroyed by Saliva.

Do. Do. by a little glue.

Do. Do. by a piece of Iron.

1824. JULY 7TH.

PER AND PROTO
SULPHO CYANATE
OF IRON.

Per sul. cy. iron evaporated on sand bath to dryness a deep red mass—on continuing heat colour changed and the whole became brown. This mass deliquescent and the greater part soluble in water, leaving per oxide of Iron and yielding a solution colourless, very slightly acid, giving red to per sul. iron—and iron (oxide) on addition of alkali. On evaporation became reddish (exposed to air) and at last deep red like per sul. cy. iron and deposited oxide, but on drying became brown just as before and furnished a colourless solution with deposition of oxide of iron as before; and this happened as often as the process repeated.

The colourless solution—white precipitate by pruss. potash becoming deep blue in the air. It tastes like a proto salt of iron. By nitric acid the solution becomes red. This solution is doubtless a *proto sul. cyanate of Iron*. The red solution a *per sul. cy. of iron*. The red solution precipitates blue by prussiate potash. The red solution is also highly acid *at all* times.

Dry proto sul. cyanate of Iron (i.e. solid) heated in a tube fused and boiled up giving sul. cyanic vapour, sul. hydrogen, a little sulphur, no ammonia and left a sulphuret of Iron which heated on platinum foil gave off sulphurous fumes ignited (burning as it were), and became oxide of Iron.

Per sul. cyanate of Iron in solution: it is rendered colourless by

{ Zinc
 { Iron filings
 { Proto Muriate of tin
 { Proto sulphate of Iron. The three first and probably the last

act by converting the per oxide of iron in the salt into prot oxide, forming proto sul. cyanate of Iron.

Per sul. cy. Iron solution has its colour destroyed by Saliva. Also by Jelly. When sol. jelly is added to the red solution colour nearly disappears; when evaporated the solid matter left is as red as the dry per sul. cy. of Iron but on dilution is as colourless as at first. Alcohol does *not* restore the red colour by precipitating the Jelly but Nitric acid immediately restores it in its full intensity.

Per sul. cy. Iron solution—colour not affected by Gum arabic, Acetic Acid, charcoal or phosphorus.

Starch and sugar appear slightly to diminish the tint. Sulphur appears to affect it slowly by boiling. Tincture of galls in small quantity scarcely affect it; in larger quantity make it dark brown or gray.

Nitric acid when cold does not readily affect it; hot destroys the colour—query Sulphuric acid.

Sulphuric acid, weak: when cold slowly discharges colour; quicker when warm.

Muriatic acid. Strong destroys the colour, weak also when warm. These acids seem to take away the Iron and then cause the decomposition of the *sul. cy. acid* producing yellow substance, etc. etc.

Alkali throws down prot oxide of Iron (hydrated) even from the red solution and does not at the same time form sulphuretted hydrogen. ? what is formed or how is prot oxide liberated or is it really protoxide.

Proto sul. cy. of Iron crystallizes on a glass plate as may be seen by the microscope. *The Per sul. cy. of Iron* very doubtful as to crystallizing.

PER AND PROTO
SULPHO CYANATE
OF IRON.

PER SULPHO
CYANATE OF IRON.

PROTO SULPHO
CYANATE OF IRON.

PROTO SULPHO
CYANATE OF IRON.

When *Proto sul. cy. of Iron* is evaporated to dryness it gives a colourless solution with water, remaining so for some time even exposed to the air—but Alcohol added to the dry mass very quickly converts the proto compound into a per compound and the whole shortly becomes deep red especially if assisted by warmth. This effect is very constant and happens with the proto salt prepared either by evaporation to dryness or by boiling with Iron—but the solution thus formed is always acid and oxide of Iron is left. This effect does not take place if the Alcohol be boiled with the salt in close vessels out of contact of air.

1824. JULY 10TH.

SULPHO CYANATE
OF AMMONIA
ANALYSED.

Sulpho-cyanate of Ammonia—acid in excess—boiled and evaporated until ready to crystallise, then placed whilst hot over sulphuric acid in exhausted receiver and left there for three days, the mass of crystals formed having during that time been broken up and stirred about 2 or 3 times.

At the end of three days a portion of the dry pulverulent salt weighed in water; it equalled 27·7 grains. This put into a flask with water and some N. Mur. acid which converts all the sulphur into Sul. acid—warmed it; violent action took place from liberation of Nitrogen and other gases and ultimately all the sulphocyanic acid destroyed—then further diluted and precipitated by Mur. baryta gave 68·9 sul. baryta = 9·35 sulphur.

SEPT. 20TH.

POTASSIUM
AND SUL. CY.
POTASSIUM.

Some Sulpho cyanide of potash heated in a tube till quite dry, then a piece of potassium dropped in and heat continued. Potassium became covered apparently with sulphur and at one moment inflamed a little but instantly was extinguished—by keeping the salt liquid the Pm. gradually dissolved without evolution of gas and rend[er]ing the salt brownish when entirely dissolved; a portion was taken out and dissolved in water—the solution by M. A. gave Sul. Hy. and precipitated sulphur—with A. of Lead it gave Sulrt. lead—with per sul. iron first black then reddish. There had not been Pm. enough to decompose whole of salt but the action seemed to be formation of sulphuret of Pm. and Cyanide of Pm.

A portion of per sulpho cyanate of Iron considerably evaporated and then placed over sul. acid in vacuo for 3 days; at the end of that time weighed in water (for salt is deliquescent) and found to equal 4.8 grains. This in solution put into a flask and treated with N. M. acid—action and disappearance of red colour—then precipitated by Mur. baryta gave 13.5 gr. sul. baryta and then ammonia threw down 1.8 gr. per oxide of Iron.

PER SULPHO
CYANATE OF IRON
ANALYSED.

13.5 sul. baryta =	1.83 sulphur		16
	1.8 per oxide Iron		15.74
salt	4.8		41.967

The residum is not sufficient to make cyanogen but if the Iron be considered as metallic then a proportion of Iron, two of sulphur and a proportion of cyanogen would nearly make the results; but the iron rather uncertain in its weight.

See on this subject of sulpho cyanates Berzelius' paper in the Annales de Chimie xvi?

AUG. 3RD, 1824.

A creeping *ceres*¹ growing in a pot has been hung up in a window—several new strong shoots have been thrown out which rise up into the air; all of these shoots have thrown out rootlets and they all proceed from those sides of the shoots which are farthest from the light—the direction of the rootlets is mostly horizontal but some proceed upwards, some downwards, according to their situation—they seem to be uninfluenced by gravity but to respect obscurity.

EFFECT OF LIGHT
ON VEGETATION.

A scarlet bean was growing in a pot in the same window and was trained on a string running upwards. The bean at first twined closely round the string as usual but on rising so high as to be level with the top of the sash it no longer twined round the string although that proceeded much higher but went off into the air towards the light.

¹ ? *Cereus*.

FLYING OF GULLS,
HAWKS, ETC.

See Aug. 20, 1823.

When at Freshwater cliffs had opportunities of again remarking the balancings of the gulls in a strong wind. Many of them would rise together and there seemed to be a sort of emulation among them; all had their heads to the wind which was here parallel to the cliffs, being about E.S.E.; they did not seem to respect the top of the cliff or any upward action of the wind from against it, but floated in the air both over the sea and the land and at various heights above and below the top of the cliffs. They did not seem able to make away against the wind or at least only slowly, but they could readily rise or fall. Sometimes they seemed to lose their balance, or the wind was too strong for them, and then they took a sweep sideways, going down with the wind but soon turning their heads to the wind, recovering their balance and slowly coming up again. All this was done without striking the air with their wings but apparently only by keeping them in a certain position with regard to the current of air.

Perhaps the effect which may sometimes be observed in flying a kite may be connected with this subject. Sometimes a kite when badly rigged will, upon rising, not cease to ascend when the string forms a certain angle with the current of air, but will continue to mount, taking nearly a horizontal position in the air, and that till the string is nearly vertical when the kite generally falls over and comes down.

AUG. 24TH, 1824.

REFLECTION OF
LIGHT IN THE
CLAUDE.

In using the *Claude*¹ it seems to me as if the various parts of the objects seen in it differ in their proportion of light from the same parts seen directly—the faint lights seem to go sooner than the others *in proportion* and the shadows to deepen out of proportion. I thought also some tints darkened more rapidly by reflection than others.

Try whether lights of different intensities are reflected in different ratios, i.e. whether faint lights have less light reflected (proportionately) than bright lights and also whether the *same* tints and colours produced from different substances (as leaves)

¹ Claude-glass—a somewhat convex dark or coloured hand-mirror, used to concentrate the features of a landscape in subdued tones (*O.E.D.*).

do not alter differently by reflection at various angles, etc. etc. Try also *coloured* glass for the *Claude*, but always with black ground, etc. etc. With this consider proper tint for printing paper—also the phenomena observed by both eyes when one has been darkened or exposed to bright light previously or when each has been previously exposed to a different colour.

REFLECTION OF
LIGHT IN THE
CLAUDE.

1824. SEPT. 20TH.

Peculiar Yellow substance—boiled in Alcohol and then placed in vacuo over Sulphuric acid for 48 hours.

ANALYSIS OF
PECULIAR YELLOW
SUBSTANCE.

2 gr. of it with 240 protoxide copper in Cooper's lamp. Tube, Asbestos, etc. 437.4 gr.

A little gas was lost at first but 5.45 c. inches were obtained—when opened strong odour of Sulphurous acid.

The quantity of water collected in the asbestos = 0.3 of grain.

There was a small portion of a volatile substance in brilliant crystals formed which passed off with the water undecomposed. It did not seem to be sulphur.

The tube seemed to have lost on the whole 3.2 grains, but a film of the copper envelope might perhaps adhere to it and make this weight a little uncertain.

The 5.45 c. i. of gas were put into contact with brown oxide of lead for an hour and a half; there was immediate action and 2.55 c. i. (Suls. acid gas) disappeared. Then solution of potash condensed 1.8 c. i. (carb. acid) and left 1.1 c. i. (nitrogen) of a gas unabsorbable by water and incombustible.

				gr.
Water = 0.3 of grain	=	.	.	hydrogen . 0.033
Nitrogen = 1.1 c. i.	=	.	.	nitrogen . 0.3217
Carb. acid = 1.8 c. i.	=	0.838 gr.	.	carbon . 0.2285
Suls. acid gas 2.55 c. i.	=	1.7213 gr.	.	Sulphur . 0.8606

1824. SEPT. 21ST.

Peculiar Yellow substance—2 gr. with 220 per oxide copper by Cooper's lamp as before.

All gas collected = 4.5 c. i.—when opened no odour of sulphurous acid gas and no sublimate formed.

ANALYSIS OF
PECULIAR YELLOW
SUBSTANCE.

Quantity of water in asbestos = 0.34 of grain—when driven off a very slight smell of sulphurous acid with it.

The 4.5 c: i: of gas in contact with brown oxide of lead had 0.25 c. inches absorbed (of Suls. acid gas). The residum treated with solution of potash gave to it 2.7 c. inches (Carb. Acid) and left 1.55 insoluble and incombustible (nitrogen). The tube when cold after the experiment was reheated to ascertain how much air would be expelled by mere expansion; it amounted to 0.12 c: i: hence Nitrogen only 1.43 c: i:

The oxide of copper dissolved in N. M. Acid and precipitated by Mur. baryta gave 12.6 gr. sul. baryta = but this result uncertain from impurity of acids.

Water 0.34 of grain =	.	.	.	.	hydrogen	.	0.038
Nitrogen 1.43 c: i: =	.	.	.	.	nitrogen	.	0.4183
Carbonic acid 2.7 c: i: =	1.2582	grain	=	carbon	.	0.3431	
Sulphurous acid gas 0.25 c: i: =	0.1687	gr.	=	sulphur	.	0.0843	
Sulphate of baryta	gr. =	.	.	.	Do.	.	

Peculiar Yellow substance—4 grains in a flask with diluted N. A. 1 acid, 1 water—warmed—action—nitrous gas evolved and smell as of Sulphuret of Carbon and cyanogen or hydrocyanic acid—substance diminished and at last left a substance resembling sulphur—boiled until whole dissolved, having added at last a little Mur. acid—diluted and precipitated by Mur. baryta—obtained 17.7 gr. of sulphate of baryta.

Again 4 gr. in diluted N. M. Acid—left cold—slow action and substance diminished; after a while warmed it—matter soon dissolved—precipitated it by Mur. baryta and obtained 21.5 gr. of sulphate of baryta = 2.915 sulphur.

100 substance contain 72.875 sulphur.

Again 4 gr. in diluted N. M. Acid—left cold, etc., then boiled, at last precipitated by a little Mur. baryta and more N. Baryta. The sulphate of baryta = 20.7 gr. = gr. of sulphur.

1824. SEPT. 22.

SULPHOCYANATE
OF POTASH AND
POTASH.

Sulpho cyanate of potash and potash both damp heated in a tube—gave water—very much ammonia; afterwards hydrosulphuret of ammonia and a tenacious brown substance, not so

fusible as the substances first used, remained which when cold became red like sulphuret of Potassium. When dissolved in water it left a little charcoal and gave a yellowish solution which by Muriatic or sulphuric acid gave sulphuretted hydrogen and a little sulphur, but afterwards by persulphate of iron no signs of sulphocyanic acid—apparently a mere mixture of Sulphuret of Potassium with charcoal, etc.

SULPHOCYANATE
OF POTASH AND
POTASH.

Sulpho cyanate of potash was heated in a tube steam passing over it at the same time. It gradually became brown and less fusible and ultimately on cooling became red like sulphuret of Potassium. On examination it was found to contain a little undecomposed sulphocyanate—then sulphuret of Pm. and sulphate of potash. The last was concluded to be present because when substance was dissolved, rendered acid by M. A., boiled to expel sul. hy. and filtered to separate little sulphur, M. Baryta caused a great precipitate. In these circumstances water forms therefore potash and sul. acid with its oxygen (perhaps also carb. acid) and amm. and sul. hydrogen with its hydrogen or assists in so doing.

SULPHO CYANATE
POTASH AND
STEAM.

1824. SEPT. 23RD.

White substance (See June 25th).

On foil heated, volatile—last portions burning carbonaceously. In open tube with turmeric paper at first water—then pungent invisible vapour, then solid white sublimate (ammoniacal salt) then abundance of ammonia, then on a sudden, disappearance of brown tint on turmeric and reproduction of pungent vapour, as if it were acid and had neutralized the ammonia forming a salt. On heating substance or water above it some free ammonia was sent off. The white sublimate was partly soluble in water and partly insoluble—the soluble portion with per-sulphate of iron gave no immediate change nor any ultimate change—the insoluble portion was also insoluble in alcohol—heated in an open tube as before its vapours were highly acid.

Some of the substance again heated in an open tube with both litmus and turmeric paper: there rose first water—then acid—then ammonia—then acid again. The volatile substance not soluble in alcohol—decidedly not sulphur—gives strong acid vapours when

PROPERTIES OF
PECULIAR WHITE
SUBSTANCE.



PROPERTIES OF
PECULIAR WHITE
SUBSTANCE.

heated in open tube as before—the part not burnt but volatilized crystallized above.

Some of the substance heated in a *close* tube with litmus and turmeric paper—first acid vapours—then abundance of ammonia and salt rose. The rest of the substance wanted a higher heat, but having that it gave a strong prussic odour and a black rim (empyreumatic or prussic) at the upper end of the tube—very little charcoal left in the bottom of the tube. A substance also rose as in the open tube—it was like it insoluble and gave acid vapours on heating.

The white substance heated with mercury—there was no action—no signs of sulphur. The heat of boiling mercury is sufficient only for the first decomposition and not sufficient to complete it.

White substance is not soluble in ether, alcohol or water.

White substance in N. M. Acid heated and boiled—liberation of Nitrous gas—solution of the whole—on cooling part deposited—rest diluted, filtered and tested for sulphuric acid—only a minute trace found. Another filtered portion evaporated to dryness left a yellow deposit insoluble in water, which heated in a tube gave first acid, then ammonia and a white substance like that from the original substance.

White substance in N. A. heated, whole dissolved—deposit on cooling—solid portion washed many times—dried and heated in tube behaved nearly as before, giving first acid fumes, then much ammonia and prussic smell, etc., hence substance unaltered.

Hot alkali strong or weak dissolves the substance—on cooling, white substance deposited which appeared like the original substance.

1824. SEPT. 24TH.

iodo sul. cyanate
of potash.

Iodine and Sul. cy. potash—heated in a tube for a long time, iodine in excess—evolution of sulphuret of carbon—sublimation of free sulphur—tube cut and salt examined—it was solid, white or gray—dissolved in water producing cold—then gave to per salt of iron a little sul. cyanic acid—to lead much iodine.

sul. cy. pot. and
iodine.

Solution of sulpho cyanate of potash in water boiled with iodine in a flask—a precipitate formed like sulphur—ultimately evaporated, driving off the excess of iodine—when nearly dry it

crystallized—dissolved a little and tested it; it contained plenty of Iodine also sulpho cyanic acid. Reboiled it with more iodine as before (having filtered out the yellow precipitate previously)—again gave yellow precipitate—repeated the operation and had the same result again. Hence the decomposition is slow and imperfect and the substance resulting each time only a mixture of sulpho cyanate and iodide and cannot be definite. Probably no definite combination of this kind.

SUL. CY. POT. AND
IODINE.

The Yellow substance precipitated—washed and dried—on foil in air burnt something like sulphur but not so readily. In tube it gave sulphuretted hydrogen and ammonia, also prussic smell—apparently carbon left, perhaps from filter. Is insoluble in water, slightly soluble in Alcohol.

1824. SEPT. 23RD.

Hydrosulphocyanic acid and muriate of potash evaporated to dryness together, dissolved and tested by iron gave slight sulpho cyanic tint.

iodo SUL. CY.
POTASH, ETC.

Sulpho cyanic acid and iodine boiled together. Iodine evaporates entirely, nothing but sol. of sulpho cyanic acid remained.

For preparation of the white substance:

PECULIAR WHITE
SUBSTANCE.

Sul. cy. potash and sul. cyanic acid boiled; no precipitate.

„ „ „ „ and Sul. Hydrogen boiled; no precipitate.

„ „ flour sulphur boiled; no action.

„ „ sulphuret of potash boiled; no action.

„ „ potash boiled; no change.

Sul. cyanic acid on Iron—evolves hydrogen and forms proto sul. cy. iron.

SUL. CY. OF IRON.

SEPT. 29TH.

Phosphuret of lime (not recently made but good) put into a tube of green glass and cyanogen (from an old cyanogen tube not previously heated and dried) sent over it. When all the common air expelled the phosphuret of lime was heated in the cyanogen. It immediately became black and continued so when cold—phosphuretted hydrogen was evolved and phosphorus

SUL. CY. OF IRON. sublimed—heat was continued till all action had ceased and pure cyanogen again passed through.

The black solid substance exposed to air smells of phos. hy.—heated on platina foil it does not burn as phosphuret of lime but undergoes a dull ignition, and leaves a gray substance which in M. A. dissolved without effervescence and by ammonia gave phosphate of lime; and afterwards by carb. ammonia a further calcareous precipitate.

The black substance in water smelt of phos. hy. but no liberation of that gas—the first portion of water was brown and slightly alkaline but per. sul. iron had no effect on it—other portions of water dissolved nothing. Then Mur. Acid dissolved all but a black charry looking substance which on plat. foil by heat gave combustion first of phosphorus a little, then of charcoal. The acid solution did not affect salts of iron. Ammonia threw down phos. lime and then carb. of ammonia threw down a little carb. of lime.

No important action in this expt.

1824. OCTR. 1.

SOLUBILITY OF
CARB: LIME.

1. Marble (Carrara) very finely powdered—boiled in distilled water—filtered and tested gave little lime to ox. amm. and phos. soda—seemed to redden turmeric when moist but not when dry—affected reddened litmus slightly—no S. A. present—evaporated, then by M. A., amm. and ox. amm. plenty of lime.

2. Washed the marble several times, boiled as before—tested, was lime as before especially on evaporation, etc.

Distilled water tested; no lime in it.

Filters washed with distilled water before being used.

3. Sub carb. soda precipitates lime water (cold) and on moderate dilution it does not appear that any lime is taken up. Weak sol. sub carb. soda does not precipitate lime water immediately—when a little stronger it does, but excess of lime water redissolves the precipitate—or dilution by water only. Perhaps wanted time. See 4, 19.

4. Lime water precipitates by sub carb. amm. but excess of solution of latter redissolves the precipitate or nearly so—on standing however a precipitate came down and on filtering no lime in solution by ox. amm. or phos. soda.

5. Lime water and weak sol. of bi carb. soda. The precipitate formed by adding the two together is soluble in excess of either or in much water. SOLUBILITY OF
CARB: LIME.

6. Sol. sub carb. of Soda and carb. of lime boiled together—filtered—no lime in solution—washed insoluble portion several times; no lime taken up as alkali removed but liquid goes through filter turbid. See 20.

7. Weak sol. of sub carb. soda on carb. lime left on sand bath all night—did not appear to dissolve any.

8. Carb. of lime and carb. of ammonia boiled together—after a while a portion filtered off before the Carb. of ammonia dissipated—no lime by ox. amm. Boiling continued till all carb. of ammonia nearly gone—liquor would not filter; left till Morning to settle.

9. Ammonia cold on carb. lime—after standing and filtering found a little lime dissolved—on evaporation more decided. Boiled together till most of ammonia flown off—did not then contain much more lime than water would have done.

10. Mur. amm. and carb. of lime boiled gave off much ammonia, probably carb. acid, and produced strong solution of lime.

11. Sol. Mur. soda containing no lime or excess of alkali boiled with carb. lime—filtered solution gave lime to ox. amm. and phos. soda—more than water alone—solution alkaline—evaporated to dryness—all resolvable and still contains lime—apparently not more alkaline than before. Second washing of the carb. lime left in flask still gave plenty of lime. REACTION OF
CARB. LIME AND
SOL. MUR. SODA,
ETC.

12. Sul. soda (pure) and carb. of lime boiled—liquor alkaline and contains plenty of lime—hence decomposition.

13. Sub carb. soda and sul. lime (solid) boiled—filtered liquor alkaline and no lime in it—washed remaining sulphate again—liquor when filtered alkaline and contained lime both to ox. am. and phos. soda—washed again, the third liquor barely alkaline but contains much lime and also S. A.—a fourth washing brought off much Sul. lime—hence decomposition not complete but certainly sub carb. soda and sul. lime compatible in weak solutions. SOL. OF CARB.
LIME.

14. Sub carb. soda in excess to sol. sul. lime—left all night cold—solution poured off contained no lime—second washing of precipitate contained lime though very alkaline—third washing

SOL. OF CARB. seemed to contain no lime or very little—fourth contained lime
LIME. again but apparently more in the first *filtered* portions than in the
after portion, but these by evaporation gave plenty of lime—the
powder in M. A. tested for S. A. gave none—was a pure carbonate.

15. Sub carb. soda in *little* excess to sol. sul. lime—precipitate—
first liquor contains plenty of lime though alkaline—second
washing contained very little lime but still appreciable, especially
by concentration. Had not had time perhaps; see 19 and 4.

16. Bi carb. soda and sul. lime both in solution evaporated
together—redissolved—first solution strongly alkaline and no
lime—second solution or washing no lime—still alkaline—third
washing a little lime taken up, hardly alkaline—on examination
a little S. A. but probably with the alkali.

17. Weak sol. of sub carb. soda and a solution of sul. lime—
when added together the precipitate formed is resolvable in excess
of either or in much water, the ultimate solution in the latter case
being still alkaline. See however 19 and 4.

18. Weak sol. of bi carb. soda and a sol. of sul. lime produce
the same effects but more readily.

19. Solutions of sub carb. soda (weak) and sulphate of lime
were mixed, being so diluted that no precipitate should take
place; one was made stronger of alkali than the other. They were
set aside very clear and transparent. Boiling a portion of the
stronger (alkaline), precipitate took place and the clear liquor
retained no lime in solution. After 3 hours examined the cold
solutions; there were precipitates in both; the stronger was still
alkaline but contained no lime. The weaker was now not at all
alkaline—and contained plenty of lime. It was poured off clear,
a little more subcarbonate added and on standing another pre-
cipitate took place—this repeated till water or liquor permanently
alkaline; then filtered and found to contain a little lime.

20. Weak solution of sub carbonate of soda on carbonate of
lime does not seem to dissolve any or at least very little; indeed
I think none. See 6.

21. Tried Carb. of ammonia to lime water and salts of lime
as mentioned Nov. 14, 1823—but did not succeed. If *time* be
allowed the effects do not take [place] as there described.

22. See June 10th, 1824—not quite accurate—see 19 above,

latter part; true only with plenty of water present and for a short time.

SOL. OF CARB.
LIME.

1824. O C T R. 4TH.

Suspect the India paper used as filter—some pure water filtered through it was found to contain lime; and when first rendered slightly alkaline by sub carb. soda, it was more alkaline on passing through an India paper filter. Hence a source of fallacy in all the preceeding experiments.

Distilled water on Powdered marble boiled and left to settle, then filtered several times through an india paper filter previously well washed, about a pint of the perfectly clear solution, i.e. the filtered water, was evaporated in a wedgewood basin to dryness. It left nothing soluble in a small quantity of water or alkaline to turmeric but it left a small quantity of solid substance which effervesced with acids and was a carbonate of lime. Before evaporation the water tested by oxalate of ammonia gave on standing decided indications of containing lime. Hence it appears undeniable that carbonate of lime is slightly soluble in water.

1824. O C T R. 5TH.

Chloride of Sulphur in Strong S. A.—no immediate action—water causes decomposition and throws down sulphur.

CHLORIDE SULPHUR
AND MUR. AMM., ETC.

Chloride of Sulphur in Pyroligneous ether—gradual decomposition.

Chloride of Sulphur on powdered mur. ammonia—no immediate action—on adding ammonia (sol. of) dark colour produced; much action and heat—added more ammonia—then washed—a reddish body left was merely hydrated sulphur.

Chloride of Sulphur in a bottle on dry powdered muriate of ammonia and left for some days; then exposed for two days to sunshine and after that left for 4 days longer—but no action.

Chloride of sulphur in a bottle with bruised glass so as to present much surface—this put into a covered jar having some carbonate of ammonia strewed over the bottom—the whole left—a crust gradually formed on the neck of the bottle which when dissolved in water left sulphur and gave a solution containing S. A., M. A. and ammonia. When evaporated to dryness and

CHLORIDE SULPHUR
AND MUR. AMM., ETC.

heated in a tube much ammonia rose, a yellow appearance like sulphate of ammonia, a strong prussic smell. Ether dissolved nothing. Alcohol dissolved salts and left Sul. am. The cyanic compds. probably formed from Carbon of Carb. Amm.

1824. OCTR. 8TH.

Carb. amm. and sulphur sublimed together and passed through a tube heated red hot. Sul. Hydrogen was formed, probably Nitrogen set free but no important results produced.

Weak sol. of ammonia made. This decomposed by sol. of chlorine gave but little nitrogen, the chlorine combining with it to form chloride of nitrogen of which the smell was very evident—but when a little potash was mixed previously with the ammonia—much more nitrogen was liberated (many times more) and no azotane seemed formed—the chlorine going apparently to the potassium. No other results were however obtained.

OCTR. 12TH.

CHLORIDE OF LIME
AND AMMONIA.

Solution of chloride of lime made (bleaching powder)—was alkaline—filtered, then clear—ammonia was added to it and stirred in in such quantities that at last turmeric paper held over the solution was reddened instantly by it—still there was no liberation of nitrogen and the mixture destroyed the colour of indigo just as before. Hence chlorine and ammonia both existed in the liquor. This solution when heated at first became almost gelatinous from deposition of lime, appearing like silica, then nitrogen gas came off (near boiling heat), the lime redissolved and ultimately a solution was left with excess of ammonia but having no further action on indigo.

A precipitate fell on making the mixture which when examined was found to be a hydrate of lime containing much water—it dissolved in water, was alkaline and dissolved in acids without effervescence.

OCTR. 13.

This morning the solution were found to have given off nitrogen and when sul. acid was added to neutralize the ammonia, strong smell of azotane was evident and the solution became yellowish.

On making a strong solution of chloride of lime and adding ammonia in excess there was some effervescence produced and lime deposited as before—when filtered the clear liquor continually gave off nitrogen gas in small quantities and was quite colourless; some was left in a bottle—a portion had S. A. added to it to neutralize the ammonia after which it would not discolour indigo. Hence the chlorine must have entered into combination, and from the non abundant liberation of nitrogen and strong odour of azotane probably with the nitrogen as azotane.

CHLORIDE OF LIME
AND AMMONIA.

Lime water alone discolour[s] weak sol. sul. indigo to a considerable extent.

1824. OCTR. 11TH.

Attempt to ascertain polarization of crystals. A small perfect crystal of nitre about 2 inches long was suspended in succession by a single silk worm fibre and a spider's thread, each being about 14 inches long. They were hung from the top of glass jars as balances of torsion, then a very large crystal of nitre was placed beneath the small crystal and as near as could be to allow freedom of motion, but after long examination no tendency to direction relative to the large crystal could be observed.

Sulphur boiled with cyanuret of mercury—no particular action.

OCTR. 18TH.

Sol. of Sulrt. potassa with excess of potassa added afterwards in solution would not absorb hydrogen gas at common temperatures.

Effervesced Glauber's salt gave no diminution of weight by fusion; hence contains no water.

Chlorine passed continuously over fused nitre caused decomposition of a small part and formation of chloride, Nitric and nitrous acids being set free, but no chlorate was formed.

Sol. pure potash boiled with sulphur for some time—deep yellow solution obtained. Sulphur in excess quite unchanged—the solution evaporated and heated when dry even to dull redness let no sulphur go—hence a definite point of sulphuration.

SULPHUR AND
POTASH.

SULPHUR AND
POTASH.

Sul. hydrogen passed through solution of pure potash until no more was absorbed—when precipitated by nit. lead gave black sulphuret of lead—acids took alkali and liberated abundance of sul. hydrogen. Evaporated to dryness in close vessels: gave sul. hydrogen and a substance white and brown in places was obtained which when heated fused and formed a reddish compound, a sulphuret of potassium like that from Sulphate of potash by carbon or hydrogen. When dissolved in water it formed a solution having the same properties as before except that it gave no sul. hydrogen on boiling. It contained no Sulphuric acid.

Some of this solution put into a flask with sulphur in excess and boiled dissolved much of it, forming a deep yellow solution darkening very much by heat and which precipitated by nit. lead.

Acids took the Alkali but liberated *no* sulphuretted hydrogen; at least no effervescence but a dense turbidness was produced and a peculiar sulphurous smell, very pungent, was occasioned. A little warmth caused the collection of a substance on the surface something resembling sulphur, but fluid and remaining fluid at low temperatures. When collected it was found to emit the peculiar smell before noticed—when evaporated spontaneously it left crystals of sulphur—when heated in a tube it gave sulphuretted hydrogen and left sulphur. It appears to be a bi-sulphurett of hydrogen. It seems also gradually decomposable into sulphur and sul. hydrogen.

The sulphuretted yellow solution evaporated to dryness in a flask gave a deep brown sulphuret of potassium from which no sulphur rose by heat. Solution of a part of it gave the solution again which by acids gave the bi sulphuretted hydrogen as before. It contained no sulphuric acid.

Another part of the dry mass was heated with more sulphur; some of the sulphur appeared to combine with it, but the rest would not nor would it even mix with it, the sulphur remaining by itself; but afterwards on adding water to the sulphuret a portion of the sulphur was set free. Hence it had taken more whilst solid than it could hold in solution in water.

Metallic copper takes away sulphur from solution of the sulphuretted hydrosulphuret of potassa and even apparently from

the pure hydrosulphuret itself, but it cannot entirely decompose the latter. SULPHUR AND POTASH.

A portion of the yellow solution of sulphuretted hydrosulphuret of potassa was put into a bottle with clean copper turnings and left for 24 hours, agitating every now and then. It gradually took all the sulphur and left nothing that would precipitate lead, brown or black.

When potash or hydrosulphuret of potash is boiled with sulphur, sulphuretted hydrogen is given off even for days together and hyposulphite, sulphite and sulphate of potash are formed. Copper added to such a miscellaneous solution frequently takes all the sulphur from the sulphuretted hydrogen without evolving hydrogen, in consequence apparently of the simultaneous reduction of some of the hyposulphurous or sulphurous acid. Much heat is excited by copper turnings in a strong solution of hydrosulphuret of potash.

Sulphate of potash in powder and powdered charcoal mixed (1 and 3 or 4 by weight) and heated to whiteness for half an hour form a strong pyrophorus.

Dry rot fungus when heated yields ammonia.

Hydrosulphuret of potassa in M. A. as Dalton and Henry describes yields a true bi sulphuret of hydrogen.

Nitrogen passed over red hot charcoal; no action.

OCTR. 22ND.

Again Effloresced Glauber: suffer no diminution of weight by heating or even fusion—no water given off—are dry. CRYSTALS OF SUL. SODA.

A saturated solution of glauber at 180° set aside in a close florence flask. After 24 hours crystals had formed in it which were perfectly transparent and appeared to be rightangled prisms with diedral summits. The flask was opened and the rest of the salt crystallized; the flask was broken and the light adhering crystals washed off by saturated solution and a brush. The group of crystals had now become quite opalescent and almost opaque; the most perfect appeared as quadrangular prisms and they were far harder than common crystals of Glauber. 55.6 gr. heated in

CRYSTALS OF SUL. a tube till all water dissipated gave a loss of 27·7; this gives dry
SODA. salt 27·9 + 27·7 water in crystals, or 8 prop. water $8 \times 9 = 72$
and one of dry salt $72 = 144$.

Again 130 grains of the same crystals, but which had a little of the common crystallised salt adhering to it, was evaporated to dryness in a basin; it lost 66 of water and left 64 of salt; again near 8 proportionals of water.

Crystals of Glauber fused in a wedgewood basin and the heat raised to 200; a solution was formed and a salt precipitated. 261 gr. of this saturated solution evaporated to dryness left 81 of dry salt which was therefore dissolved in 180 of water and $81 : 180 :: 72 : 160$ so that 1 prop. of salt dissolves in about 18 prop. of water.

The precipitated salt was pressed in hot dry paper and in hot cloths and when heated appeared to contain but little water and that probably due to solution adhering to it; the salt as thrown down appears to be anhydrous.

The usual crystals of glauber contain 10 prop. of water.

So that when they are heated $\frac{5}{9}$ of the salt takes all the water to form a saturated solution and $\frac{4}{9}$ precipitate in an anhydrous state.

1824. OCTR. 26TH.

Heated potash, sulphur and charcoal together, sulphur in excess—no sulphuret of carbon formed—carbonic acid given off—no peculiar or striking effects.

Chloride of sulphur over cyanide of mercury at moderate temperature—action and production of cyanogen—sulphur, chloride of mercury, sulphuret of mercury, etc. but no particular action.

NOVR. 3RD.

Chloride of sulphur in retort with cyanogen: no action either in day light or by heat.

Sulphuric acid and chloride of silver heated—some action and a small portion of sulphate of silver formed.

Nitric acid and chloride of silver: very little action, very little nitrate formed.

Nit. amm. and chloride of silver heated: very little or no action, a little nitrate of silver formed.

Caoutchouc sap or juice a thick pale yellow creamy looking substance of uniform consistency and S. G. 1011.74. It had an unpleasant acescent¹ odour something resembling that of butter milk or sour milk. Exposed to the air it soon dried, loosing in weight and leaving caoutchouc of the usual appearance and colour and very tough and elastic. 202.4 gr. of the sap put into a wedge-wood basin and dried at about 100 became in a few days 94.4, and being then removed from the capsule and left exposed at both surfaces to the air it became after 2 or 3 days 91 grains.

On being taken out of the capsule it was found that a partial separation of the elements of the sap had taken place, a small portion of matter had fallen and formed a thin layer (perhaps half a grain) of a peculiar substance on the bottom of the basin, and it appeared as if this matter was in greater quantity in the lower surface of the caoutchouc than the upper. It was brownish, shining, soluble in water, bitter and precipitated per sul. of Iron green; it is the same as a substance presently to be described.

Some of the sap poured into alcohol not very strong was partly coagulated and partly a white precipitate; the coagulum when taken out, washed, pressed and dried was elastic solid caoutchouc. The rest filtered left white powder on filter which dried also cohered into a mass of caoutchouc. The alcoholic solution brownish—precipitated slightly by water—gave green precipitate with per sul. Iron—evaporated, left but little matter tasting very bitter and was brownish—this almost entirely soluble in water; solution filtered and evaporated left dry brown shining matter like a varnish and cracked over its surface—taste bitter—soluble in water or alcohol—burning with flame smelling like quill and leaving bulky charcoal—in tube does not yield ammonia—precipitates green with per sul. of Iron—white with pure proto sulphate—became bright yellow by alkali—colourless with acid—but no precipitate in either case—alkali added to it increases the green tint by iron—and in greater quantity causes a brown precipitate with the sul. iron much deeper than that with alkali alone.

Some of the Sap put into about two parts of water easily miscible—no other change on standing, no change when eva-

¹ The spelling is corrected to 'acescent' in *Experimental Researches in Chemistry and Physics*, p. 174 (1859). Acescent = slightly sour (O.E.D.).

CAOUTCHOUC SAP. porated in basin or on paper; is as if it were a weak sap, no otherwise—same results ultimately as with strong sap. Diluted M. A. produces no change in this weak sap. Alkali makes it yellow—does not appear to dissolve the caoutchouc—destroys the acid smell and make a positive stink evident—on standing a while, as two days, and more diluted it does not seem to separate so easily as from water alone (as is to be described) but otherwise no change. M. A. added after 2 days puts things just as they were.

Alcohol added to the diluted sap—no change unless alcohol in great quantity and then coagulation, etc. A little M. A. added facilitates this separation, and the caoutchouc set free is beautifully white and elastic and exhibits the change of temperature by extension extremely well.

Diluted sap heated in tube—coagulation of the caoutchouc and gradually the whole separated—a deep brown solution left containing the bitter principle before mentioned.

A mixture of one sap one water—added oil of turpentine and agitated—imperfectly miscible—on standing 24 hours three portions formed—the lower water containing the usual dark coloured soluble substance and very little caoutchouc—the upper clear and like oil of turpentine—filtered was clear and fluid but somewhat tenacious and stringy between the fingers and held caoutchouc in solution—the third portion a clot or tenacious mass, soft, adhesive and like birdlime, contained caoutchouc and oil of turpentine—when heated let loose a little watery solution and became dark, but still adhesive as before—very difficult to dry and always sticking and tacky. The turpentine solution on evaporation per se became yellow, more adhesive—thickens, but adhesive and tacky, is rather heavier than water; further evaporation left a substance quite hard when cold, yellow and transparent, brittle—soluble in alcohol almost entirely and precipitated by water—caoutchouc then liberated. It is resin with a little caoutchouc. Some of the same turpentine solution boiled with water left similar results.

Some of the sap was further diluted with water—after standing some time the creamy white caoutchouc rose leaving a dark coloured aqueous solution beneath. The two portions were separated and the caoutchouc diffused through more water—on

standing it rose again and was then beautifully white—when put on paper or in a capsule it evaporated just as at first, but the caoutchouc remaining was beautiful in its appearance and fully as elastic as before. CAOUTCHOUC SAP.

The aqueous solution was brown—filtered it became clear—was very bitter—became yellow by alkali, green by per sul. iron—colourless by acids. Slightly precipitated by alcohol—evaporated gave a yellow shining substance like resin almost entirely soluble in water and containing the same substance as that before spoken of.

The water evidently separates a soluble substance from the pure white insoluble caoutchouc.

981 grains of the original sap in water and washed gave a solution which when boiled threw down coagulum amounting to 18.6 gr. when dried—and the solution then evaporated until it when cold formed a dry brittle extract = 116 gr.; it was deliquescent. The washed caoutchouc coagulated by heat and dried amounted to 331 grains. Jan. 8, 1825. Now weighs 311 gr., is dark brown and nearly transparent throughout. The 116 digested in alcohol left insoluble 28.5 and the soluble part on evaporation gave 70 gr.

1824. NOV. 15TH.

Properties of brown aqueous solution—was bitter—deep brown—acid to litmus paper—difficult to filter—when boiled vapour even acid—a precipitate fell which settled to the bottom and was not therefore caoutchouc and now the solution became clear either by standing or filtering—when filtered and the substance on the filter dried it became hard, deep brown, glassy like caoutchouc, but was brittle and not elastic—it was not soluble in alcohol and burnt with an odour resembling common india rubber—solution of soda dissolved out something forming brown solution and left a pure white undissolved film of caoutchouc—the soda solution did not precipitate iron green.

The brown aqueous solution appeared frothy on boiling or agitation—on adding alkali became deep yellow and an unpleasant putrescent odour was produced, like that from quick lime or alkali or white of egg or blood. The green colour with per sul.

CAOUTCHOUC SAP. Iron appears not to be a precipitate for it goes through the filter. The brown solution produces no precipitates in

Mur. Baryta or

Mur. Mang.

Mur. Zinc—dense yellow precipitate.

Prot. Mur. Tin—dense white.

Prot. Mur. Copper—dingy green.

Per Mur. Copper—none till Alkali added then good green.

N. Lead—yellow, deeper by alkali.

N. Bismuth—whitish.

M. Cerium—whitish.

M. Chromium—greenish.

P. N. Mer.—white.

Per N. Mer.—none.

N. Silver—whitish.

1824. NOV. 16TH.

The boiled brown solution when concentrated and then acted on by Alcohol gave one part soluble in alcohol (*a*)—another part insoluble which, separated by a filter and well washed with alcohol, afterwards treated with water gave a deep brown aqueous solution (*b*) and a small insoluble portion left (*c*).

(*a*) Evaporated to dryness left brown brittle transparent body—becoming soft by exposure to moist air—heated on plat. foil does not burn easily but runs out into bulky charcoal much like animal matter—is very bitter—does not yield ammonia when heated per se though smell very animal—heated with common potash plenty of amm. *—sol. in water—colours iron very green—is slightly acid—has no appearance of an alkali. The solid matter put into ether had something dissolved, for ether solution on evaporation left little globules, solid like wax at 60° and of the same colour and appearance—but fluid at 100°—lighter than water—insoluble in it—but washed with water washing gave little green to iron—this waxy substance is heavier than alcohol—slightly soluble in hot alcohol—requires high temp. for its decomposition and then yields products like those from oil or wax. Alkalies did not

* but string and paper heated with potash yield ammonia.

dissolve it cold—readily when heated—M. A. threw it down again. CAOUTCHOUC SAP.
There is but little of this substance present.

(b) solution deep brown—almost tasteless—evaporated to dryness forms greenish shining brittle substance—resoluble in water, etc.—when heated in tube yielding ammonia—it is precipitated by alcohol—makes per sul. Iron dark green—alkali makes it yellow—Mur. Acid precipitates a reddish brown substance from it resolvable perfectly in water. The M. A. filtered off gave a little green to iron—the insoluble portion dissolved in water did not give green tint to iron even when alkali added—seems to be somewhat purified by the M. A.—dried, it formed a substance pulverulent, burning but not with facility and yielding a little ammonia in a tube.

(c) dark, almost black—appearance of an insoluble extract—when dried not elastic—tasteless—brittle—burns with difficulty and in tube gives much ammonia.

DECR. 3.

Liquid from condensed oil gas has been treated with chlorine OIL GAS LIQUID
water and sunshine until converted into a soft substance re- AND CHLORINE.
sembling honey, containing granular crystalline particles mixed with a fluid—it is not affected by water—it has a remarkably hot pungent and persisting taste—heat evolves much M. Acid—a white substance sublimates and leaves much charcoal. There appear to be two substances at first, a liquid and a solid, and after heating there appears to be a substance not readily changed by heat, though before one part was easily resolved into M. A. and carbon.

1824. NOV. 16.

Caoutchouc washed several times in water—a portion of the [CAOUTCHOUC SAP.]
cleansed milky caoutchouc mixed up with olive oil—when beaten up formed a singularly adhesive stringy substance holding the water in its interstices—it was stringy, pearly in appearance and tenacious—when heated so as to drive off the water it became oily, fluid and clear—on adding water and stirring considerably it became adhesive as before.

A portion of the cleaned milky caoutchouc had alkali added to it—no action—boiled—caoutchouc separated as a coagulum—

CAOUTCHOUC SAP. after some boiling—separated the liquor, evaporated it to dryness and redissolved. Alkali had taken a little caoutchouc but almost all coagulated at first.

Some of the cleaned milky caoutchouc to sol. of per sul. iron—no colour (green) produced—added a little of the aqueous solution and evaporated—colour very bad.

Some of it with Alcohol and camphor—nothing particular. Caoutchouc—camphorated and odorous.

Some of it poured on a dry absorbent surface immediately coagulated.

Some coloured in various ways—body colours hot [?] and should be well mixed in—Indigo—Cinnaber—Chrome yellow—Rouge—Carmine.

Washing of Caoutchouc—last washings do not separate so well; this obviated by washing with saline solutions. Thus Muriate of Soda or Muriatic acid both throw it up well and quickly. Sul. Soda, Sul. Magnesia probably also.

Properties of the part coagulated from the aqueous solution by heat. Is a dark coloured shiny brittle mass heavier much than water—not soluble in Alcohol, Ether, Water. Effect on fixed oils?

Weak alkali dissolves it giving deep brown solution—filtered and precipitated by M. A. dilute—precipitate greyish—acid has a little colour but not much—when evaporated the acid gave but little soluble matter—but that when heated smelled ammoniacal and tasted as if it contained Mur. Ammonia. Alcohol boiled on it took very little up. Ether took up a mere trace. It burns on foil like animal matter with flame, leaving bulky charcoal, and in a tube when heated chars and yields very much ammonia.

The aqueous solution left after boiling and filtering has been precipitated by nitrate of lead which left no colour in the solution although it was previously of a deep brown tint. The precipitate was greenish. When well washed it was diffused through water and sul. hydrogen passed through it. This changed the green to a deep brown, not to a black. It was filtered. A yellowish solution went through and a black substance remained on the filter (deep brown rather). This washed and dried was in small quantity only, brittle, rather hard—when heated on foil burnt like animal matter with a good deal of flame and odour of ammonia, swelling much;

after that sulphurous acid and ultimately lead and oxide of lead left. When heated in a tube it gave very much ammonia. It appears like an highly animalized substance. Digested with alcohol a very minute portion only was dissolved out and that gave green tint with iron. CAOUTCHOUC SAP.

The Sul. hy. solution boiled and evaporated left a yellow shining substance resembling a varnish in appearance—not deliquescent—soluble in water—acid to taste and to litmus—no ammonia by heat—green by per sul. Iron—by nitrate of lead greyish—the acid not sulphuric acid.

Caoutchine.

Substance insoluble in Ether, Alcohol, water, etc.; not [illegible]. Bitter precipitating principle.

Wax.

Substance sol. in water not in Alcohol.

Insoluble brittle Amm. substance.

1825, *Novr. 4th*. Some pure caoutchouc has been left mixed with water nearly a twelvemonth; it has risen to surface in a thin film but has not changed otherwise and is just as miscible as ever with the water beneath.

1824. DECR. 13.

Chromate of potash solution made very alkaline—diluted nitrate of lead added to it—after standing some time small red crystals of chromate of lead formed quite resembling the red lead ore of Siberia. CRYSTD. CHROM. LEAD.

1824. DECR. 21.

Some crystals of carbonate of soda were pulverised and exposed to air to effloresce several weeks ago, and at the same time some other crystals were fused so as to be made quite dry, pulverised and left in a basin by the side of the first—both covered with paper. EFFLORESCED CARB. SODA.

To day 150 gr. of the effloresced carbonate upon fusion lost

EFFLORESCED 85 gr. of water and 150 of the pulverised fused carbonate upon
CARB. SODA. being refuzed lost 84 gr. of water. The first compound therefore
of 85 water, 65 dry carbonate—the second of 84 water, 66 car-
bonate.

carb. water carb. water

65 : 85 :: 54 : 70·6—this not quite 8 prop. water.

66 : 84 :: 54 : 69 —this not so near 8 prop. as above.

100 parts of the second lost by S. A. 17·9 carb. acid; the 100 con-
tained as above 44 dry carb. and consequently 25·9 soda and

25·9 : 17·9 :: 32 : 22 nearly; hence the loss water and not
Carb. acid—no carb. acid had been absorbed.

1824. DECR. 28TH.

Expected that an electro magnetic current passing through a
wire would be affected by the approach of a strong magnetic
pole to the wire so as to indicate some effect of reaction in other
parts of the wire—but could not perceive any effects of this kind.
The power was from 2 to 30 pr. of 4 inch plates. The circuit was
made long, short, of moderate copper wire—of very fine silver
wire—the indicating needle was put into a galvanometer. The
pole was put into a helix, etc. etc., but in no case did the magnet
seem to affect the current so as to alter its intensity as shewn
upon a magnetic needle placed under a distant part of it, although
the M. Pole was so strong as to make the wire bend in its en-
deavours to pass round it.

1824. DECR. 30TH.

PRODUCTION OF
AMMONIA.

Singular production of ammonia.

Piece of pure potash heated in glass tube—no signs of am-
monia—a piece of writing paper dropped on to it and heated
with it—abundance of ammonia to turmeric paper and to Mur.
acid fumes.

Potash with tow—much ammonia.

Do. Do. much ammonia.

Tow or paper alone—no ammonia.

Potash with large crystal of sugar—no ammonia.

Potash with little sugar—a little ammonia.

Potash with piece of charcoal—a little ammonia.
 Carb. potash with paper—a little ammonia.
 Carb. potash with tow—a little ammonia.
 Hydrated lime alone (old)—a little ammonia.
 Hydrated lime with paper—more ammonia.

PRODUCTION OF
 AMMONIA.

JAN. 8TH, 1825.

Linen with Potash in tube—no cyanogen apparently.
 Cotton with Do. — Do.

Linen in retort moistened with strong solution of potash—heated—retort cracked but continued the heat—water, etc., distilled over into condenser—ceased the distillation—opened the retort—only the exterior of the linen acted upon. Water in condenser very alkaline to turmeric—brown tint dissipated by heat like ammonia—strong odour of pyroligneous ether—taste also ethereal, hot and rather empyreumatic—liquor transparent and colourless—three drops of Sul. Acid added by mistake instead of Mur. Acid—neutralised alkali and rendered the liquor acid—evaporated—pyroligneous smell and ultimately a charring of the contents of the basin; at last a black dense fluid in small quantity and very acid—put a little of this on paper into a tube with hydrate potassa—heated, much ammonia rose—at least brown or reddened turmeric paper and rendered red litmus paper blue—but still did not smell so much of ammonia as of empyreuma—must try alkali again.

JAN. 11TH.

The portion not decomposed (of linen, etc.) redistilled and the product received into a flask—the liquor in quantity from water added and not alkaline—was tarry and empyreumatic—a few drops of M. A. added and the whole filtered—filtered again the solution slight yellow—odour pyroligneous ether—evaporated to dryness left dark residuum, pitchy and soft—put it into a tube with potash and heated; much ammonia came over to turmeric paper—not enough to collect gas.

Potash with resin in tube—no ammonia.
 Potash with coal asphaltum—much ammonia.

PRODUCTION OF
AMMONIA.

		Pure Potash in vapour of Naphthaline in tube—some ammonia.	
	„ „	with white bees wax	Do. do.
	„ „	in vapour of Alcohol	Do. none.
	„ „	in vapour of ether	Do. none.
		Potash heated red and Oleft. gas passed through—none.	
		Potassa fusa alone in tube.	
Little	„ „	with linen	Do. —plenty ammonia.
much	„ „	Do.	Do. —more than above.
		Potassa fusa—tartaric acid	Do. —a very little amm.
	„ „	bi tart. potash	Do. —some.
	„ „	neutral tart. potash	Do. —plenty.
	„ „	oxalic acid	Do. —little.
	„ „	oxalate potash	Do. —very much. *
	„ „	acetate potash	Do. —some.

* The ammonia was so abundant with the oxalate of potash that I suspect the salt must contain some—must make a fresh oxalate.

Sulphuric acid heated with linen—when charred washed out the Acid—neutralised almost with potash—evaporated to dryness and heated the salt obtained with excess of potash in tube—the appearances of ammonia doubtful but think there was some—when the salt and alkali were heated together in strong solution was more decidedly ammoniacal. Repeat, etc.

1825. JAN Y. 17TH.

Potassa fusa with oxalate of lead in tube—very little if any amm.
 „ „ „ tartrate of lead „ —much ammonia.
 Tartrate of lead in tube alone . . . —none.
 Potassa fusa with pure Benzoate potassa—some ammonia.

Strong Mur. acid boiled on linen—linen soon broke down and became brown—filtered—evaporated solution which was a pale brown—a substance obtained of a dark colour and rather charred, charred apparently at low temperature—was not acid and tasted slightly bitter—it was adhesive or else brittle and nearly black—

it burnt on plat. foil with difficulty and very little flame—it left much ash which was fusible by blow pipe but not sapid. In water the evaporated substance dissolved giving a deep brown solution and leaving a little insoluble charred substance—it became slightly darker by per sul. Iron.

The solid substance gave very little ammonia by potash.

The insoluble part—brown when washed and dried—tastes in mouth like starch—insol. in water—burns readily with bluish flame—give a little ammonia with potash in tube.

Sent M. A. Gas over linen in a tube at 380° : linen blackened and empyreumatic smell produced—tarry matter, etc. etc. collecting in farther part of the tube. The linen was black—friable—tasteless—burned with flame—is charred—in tube yields water—gas inflammable—empyreuma—a little ammonia with potash but not much.

Potassa fusa with Acetate of lime in tube—plenty amm. Pure salt?

„ „ „ Pure Oxalate potash „ —ammonia not so much as before but plenty.

„ „ „ oxalate of lime „ —plenty ammonia.

Lime with linen in tube—plenty of ammonia on first impression of heat—no more by continuance of heat.

lime alone „ —no ammonia.

FEBY. 3

3 Vols. hydrogen 1 Nitrogen mixed and passed over spongy platina in a green glass tube heated to various degrees up to dull redness—no traces of formation of ammonia.

Finely pulverised Carrara marble alone in tube—no ammonia.

„ „ „ with little gum in tube—no certain trace of amm.

„ „ „ with linen in „ Do.

Hydrate of lime in shelf bottle gives little ammonia when heated.

Linen (flos almost) with red lead in tube—no trace of ammonia.

„ „ „ yellow oxide lead—no trace amm.

„ „ „ scales of iron—no certain trace.

„ „ „ oxide of zinc—no ammonia.

„ „ „ recently heated per ox. iron—no ammonia.

PRODUCTION OF
AMMONIA.

PRODUCTION OF
AMMONIA.

- Linen (flos almost) with chloride antimony—nothing.
 „ „ „ protoxide Manganese—nothing.
 Dry lime and dry linen in tube—very little amm.
 „ „ undried linen Do.—ammonia and
 pyrolig. ether.
 Pure hydrate lime and linen—plenty ammonia.
 Potassa fusa and resin in tube—little resin—ammonia formed; re-
 quires continued heat to decompose
 the resin; not readily decomposed.
 „ „ little sugar in tube—little ammonia.
 „ „ alone—none unless dirty; then am-
 monia formed—the effect is very
 striking if the potassa be fused at
 bottom of tube and then a pellet of
 paper or linen be dropped in.
 „ „ neutral tartrate potassa—a little ammonia only.
 „ „ pure oxalate potassa—plenty during first action;
 none afterwards when charred.
 „ „ tartrate of lead . . .—very much ammonia; as
 water flows down on to residue be-
 low striking effect.
 „ „ emetic tartar—none or very little.

Some linen put into a retort with very strong solution of potash—distilled to dryness, the products being received in three portions—the *first* about half the water off with a little potash which boiled over—during this time the linen had not broken down or become much discoloured—the *second* was about half the remaining water—during this time the linen had softened, broken up in part and become much browner and permanent gas had during the latter part of the time bubbled from the mouth of the retort—the *third* was collected until the retort was dry—gas of a pyroligneous and empyreumatic odour came over but quite transparent and colourless. All of these contained some potash which had passed over.

No. 1. or first—alkaline—redistilled carefully—still alkaline from potash—neutralised by M. A.—evaporated to dryness—the salt collected and put into a tube with potash dry—when heated was plenty of ammonia.

No. 2. alkaline and foul—redistilled—still alkaline—M. A.—evaporated—then heated with potash in a tube; more ammonia than before—the characters of the ammonia tested by turmeric paper—volatility—solubility in water—M. Acid vapours—sul. copper (made blue) and by smell—satisfactory with all of them.

No. 3. redistilled—saturated—was not previously very alkaline to turmeric—evaporated—left but little salt but that with potash in tube gave as much if not more ammonia than before—tested in all ways as to its nature.

The dry residue in the retort dissolved in water—distilled—the product neutralized by M. A.—evaporated—the residue heated with potash—gave very little ammonia.

1825. FEBY. 7TH.

Potassa fusa and pure acetate of lime in tube—ammonia—also a second portion on letting the water down.

„ „ and acetate lead in tube—water, then little ammonia with care.

„ „ olive oil „ —ammonia at first.

Oxide of lead and acetate of lead in tube—acetic acid, etc., no alkali.

Tartrate of lead alone in tube—no ammonia alone—or afterwards with water—on adding potassa, plenty.

Potassa fusa and clean tin foil in tube—much ammonia.

„ „ and clean zinc foil in tube—plenty ammonia.

„ „ and spongy platina „ „ —no ammonia; added zinc plenty.

„ „ and copper wire fine „ „ —very little ammonia—added zinc wire plenty.

„ „ and Iron wire „ „ —much at first — then ceased; surface of wire oxidated — fresh clean wire dropped in—fresh evolution of ammonia.

„ „ and prot. oxide manganese—very little at first—then none—no chameleon formed without access of air.

PRODUCTION OF
AMMONIA.

Potassa fusa and arsenic in fragments—very much ammonia at first—better than any thing else almost.
 „ „ alone in tube—sometimes a little ammonia.
 Quick lime alone „ „ —no ammonia.
 „ „ with little water—sometimes a trace.
 Hydrate of lime „ „ —generally a little ammonia.
 Potassa fusa and quick lime—sometimes ammonia, sometimes none; must work with pure materials.

1825. FEBY. 8TH.

A tube bent and drawn out as in margin*—some clean zinc foil put at *z*—some carefully fused and unhandled potash at *pot.*, a piece of turmeric paper in the bend—the end *a* fastened into a cap—the end *b* dipped into mercury and then about 100 c:i: of pure hydrogen passed through—the tube was then sealed at *s* and was considered as having all nitrogen excluded. Upon making the potash hot a very slight trace of ammonia appeared on the turmeric paper (perhaps from the zinc in the hydrogen or indeed the action of the hydrogen itself)—but upon bringing the potash and zinc together and heating—much ammonia formed—was a very good experiment.

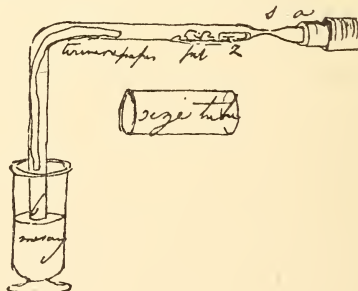
Same form of experiment but with the fused potash in the hydrogen only, no zinc being present—obtained a minute trace of ammonia.

Again with fused potash in arseniuretted hydrogen—very little ammonia on action of heat—but was a little.

Arsenic and potassa fusa (common) in tube of usual form—introduced a paper moistened in mixed solution of nitrate of silver and arsenious acid—yellow arsenate immediately produced by the ammonia.

Powdered Arsenic in strong sol. of potash in retort—distilled, received half the water separate—then in another vessel received the rest of the water—and then in a third distilled into a portion of pure water in a third vessel—gas coming over (arseniuretted hydrogen) at the same time—examine for ammonia by neutralizing with M. A., evaporating to dryness and heating residue with potash in tube—1st product no ammonia—2nd product plenty—

*



3rd product none—residue with water distilled; no ammonia—
 examined residue—no arsenious acid in it either to sul. copper or
 nitrate silver—the black divided powder remaining upon washing
 when dried and heated in a tube appeared to be pure metallic
 arsenic.

PRODUCTION OF
 AMMONIA.

FEBY. 10TH.

Pure caustic lime alone in tube—no ammonia—addition of
 water—no ammonia.

Pure hydrate of lime in clean tube—no ammonia.

Pure lime or hydrate mixed with pure potassa in clean tube—
 no ammonia.

Zinc dissolved in S. A.—the solution treated with potassa fusa
 in excess, it having been previously heated—distilled—the product
 neutralised by M. A.—evaporated and heated in tube with potash—
 gave much ammonia—? if from potash or from action of acid
 on metal.

Very dry turmeric paper in very dry ammoniacal gas; scarcely
 has its colour affected by it.

Pure dry lime with zinc; hardly a trace of ammonia.

Effect of fingering. Heated sea sand red hot—cooled it on a
 copper plate—introduced some into a tube and heated; no signs of
 ammonia—put a little into the palm of the hand and moved it for
 a second or two with a finger; this put into a tube and heated gave
 plenty of ammonia.

Precise experiment. Put distilled water into a clean retort—
 distilled till half over—then condensed a little in a new clean
 closed glass tube which had been cleaned by heating red and not
 by wiping—thus collected a little pure water—cut pieces of
 potassium with a lancet from the middle of a lump and dropped
 them into the tube—inflamed forming an atmosphere of hydrogen
 above and solution of pure potash; heated the tube about 2 inches
 from bottom and contracted to a capillary aperture—then evap-
 orated the solution in this tube till potash sufficiently con-
 centrated—cooled it—prepared a tube as before (Feby. 8th)—put
 in the zinc and potash and adopted all the former precautions.
 The water for the trough boiled in a close boiler over night for
 some hours—put into trough just before it was used. Jars filled

PRODUCTION OF
AMMONIA.

up to stop cocks with the water. Gas bottle quite filled with water before putting the acid in—full. 100 c: i: of the hydrogen gas passed through the tube and so on—yet still on heating the potash and zinc together plenty of ammonia.

The potash quite colourless.

Also made a potash by calcining tartar—lixiviating—treating with lime made for the purpose and evaporating the solution of caustic potash by boiling in florence flasks—pouring out at last on to copper plates—breaking up the potash with platina tools and putting it into the bottles with forceps. The solution was never filtered but cleared by decantation and the potash never touched any vessels or other things but such as were of glass—stone (as crucible)—platina or brass—no fingers, paper or cloth—yet with zinc plenty of ammonia.

FEBY. 14TH.

Caustic potash heated with zinc foil so as to evolve all the ammonia possible—then dissolved in pure water; allowed to stand—the clear portion (containing of course some oxide of zinc) poured off and evaporated in a clean flask—this potash with clean zinc in hydrogen gave abundance of ammonia.

The zinc potash alone also gave ammonia—more than from any other specimen of potash or lime at any time.

Hydrate of lime (pure, exposed to air for 3 day[s]) gave ammonia in tube by heat—not much.

Caustic lime exposed in same circumstances gave more ammonia than hydrate.

Arsenic carefully washed from the Arsenic and potash experiment (Feby. 8th) which gave no ammonia by itself gave plenty with tartar potash, yet no arsenious acid formed.

Zinc in carbonate of potash—very variable and uncertain results.

FEBY. 15TH.

Potash from tartar with tartrate of lead—much ammonia even at first—when exhausted, on letting down water more ammonia—must repeat with carefully made tartrate of lead.

Potash from tartar with pure oxalate potassa—plenty of am-

[OXALIC ACID.] densing crystallises again. This sub hydrated acid may be repeatedly volatilised with care without any particular change.

If the temperature be higher and applied rapidly then decomposition is effected; carbonic oxide and acid result, a little carburetted hydrogen to smell—stain of charcoal, etc., water apparently having been decomposed.

Thenard says in red hot tube decomposed without deposition of carbon. iii, 90.

Oxalic acid mixed with sublimed sulphur and heated was decomposed readily with strong effervescence, the sulphur apparently acting upon it—gases collected over mercury proved to be a mixture of equal vols. carb. oxide and acid—a very slight odour of sulphurous acid existed in it but otherwise sulphur was unchanged. It appeared merely to have acted by contact, inducing ready decomposition.

Spongy platinum had precisely the same effect: dropped into melted heated oxalic acid in tube it immediately caused decomposition into carb. oxide and acid.

1825. MARCH 29.

OXALIC ACID DE-
COMPOSED IN S. A.

Crystals of Oxalic acid in strong Sulphuric acid—heated gases collected over mercury—no blackening of S. A. and decomposition went on very readily, great effervescence taking place—at last it suddenly ceases—the oxalic acid being all decomposed and the S. A. remained somewhat diluted—the latter portion of gas had a smell of sulphurous acid gas but quantity tested by per oxide lead very small. Sol. potash added to the gases divided them, absorbing carbonic acid to the amount of one half and leaving pure carbonic oxide—in two or three experiments the mean of quantities was rather more than one half carbonic oxide.

Oxalic acid in S. A.; no action whilst cold.

Neutral oxalate ammonia heated in tube gave ammonia, carb. ammonia, carb. oxide, etc., and ultimately a little hydrocyanic acid or compound.

Potassium in ox. ammonia crystallised—by heat burnt into potash containing a little cyanuret—the presence or formation of the latter body the object of the experiment.

Oxalate of ammonia and sulphur heated in tube—no cyanic

compounds—results, ammonia, sul. hydrogen—Carbonic acid and oxide and sulphur left. OXALIC ACID DE-COMPOSED IN S. A.

Oxalate of Ammonia and Sul. acid—results similar to oxalic acid and S. A.

Oxalate of Soda—pulverised—heated in a basin to dry it as far as might be—acid fumes arose—then put into tube retort—distilled and gas received over mercury—several jars of it—then tube heated in fire to complete decomposition.

Gas combustible—mixture of carb. oxide and acid—had slight smell of carburetted hydrogen or of ammonia—by potash, mixture contained carb. oxide to of carb. acid. The carb. oxide separated burnt with a purplish tint (slight).

Residue in tube—black—alkaline—dissolved in water—carbon left and carb. Soda obtained.

Oxalate of Soda and sulphur rubbed together—heated—gas came off not combustible except from sulphur—sulphur rose—residue deep brown, soluble in water leaving no charcoal—but a heavy substance which, washed, etc., proved to be oxalate soda undecomposed.

Oxalate of soda dry in Strong S. A.—no action when cold—when heated, gas—which consisted of equal vols. of carb. oxide and acid—no charring or blackening of acid.

Oxalates of lead

„ „ zinc	} dry salts.
„ „ manganese	
„ „ Iron per	

EXPTS. ON OXALIC ACID.

See results of distillation of oxalates. Thenard, iii, 99.

Refer to Ann. Phil. N.S., ii, 136. Thomson.

„ Ann. de Chimie, xv, 125.

„ Recherches by Gay Lussac and Thenard.

„ Thom. Ann., iv, 232; v, 97; ix, 33. Berzelius.

„ Phil. Trans., 1822, p. 480. Ure.

Oxalate of lead by heat—yields carbonic acid and metallic lead.

APRIL 2ND.

Oxalate of ammonia in fluoboric gas—hoped to have produced cyanogen and water from elements of the salt—but the fluoboric

EXPTS. ON OXALIC ACID. gas took water and ammonia from the salt and left either an acid oxalate or Carbonic oxide and acid.

Oxalate of lead with sulphur—heat—sulrt. lead and carb. acid.

Oxalate amm.—Mur. acid and oxide Mang. distilled. Carbonic acid in great abundance—all oxalic acid decomposed.

Mur. Amm—Oxalic acid—oxide Manganese—nothing. Oxalic

acid: Carbon 2 prop. 12

Oxygen 3 „ 24

36

Water it is said correctly 36

72 crystd. oxalic acid from solution.

Oxalate ammonia heated over spongy platina—ammonia at first—hydrocyanic acid smell at last—a little.

Oxalic acid crystd. from Alcohol—contains plenty water.

Sols. of Cor. sub. and ox. am., equal vols. in dark and light—strong solar effect—Planche, Jour. de Pharmacie, vii, 62.

Cyanuret of mercury heated in carbonic oxide—in sun light—white crystals sublime—resist heat more than cyanuret of mercury—retort opened—smell of cyanogen—a little free mercury—crystals volatile and condensable—contain mercury when tested by rubbing on copper or by taste—in air sublime with decomposition—soluble in water—no[t] so much so apparently in alcohol.

Was merely dry cyanuret of mercury—has been no action apparently.

Carbonic oxide gas and scentless carbonate ammonia with little water exposed to sun light in glass retort.

Carb. oxide and sesqui carb. ammonia—water, etc. in sunlight.

Carb. oxide—carb. pot. and water in sunlight.

These exposed till April 12th, all bright days—at that time examined—no carb. oxide had disappeared—no oxalic acid had been formed—no change of any kind.

1825. APRIL 4.

Carb. oxide and cyanogen gas equal vols. and carbonic oxide and iodine exposed to solar light in glass retort till April 12—then examined—no change.

Cyanuret of mercury and oxalate of lime heated together—nothing particular. EXPTS. ON OXALIC ACID.

Iodine and oxalic acid heated together—no particular action.

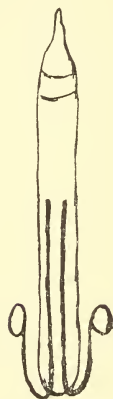
Oxalic acid and phosphorus heated together—vapour of phosphorus carried up but no permanent compound—nothing particular.

Oxalic acid and sulphur heated together again—nearly as before—action as to decomposition not quite so much as I expected.

1825. APRIL 12TH.

Mr. Brande has been making an experiment these last few days of the following kind. A strong tube has been prepared with 2 plat. wires sealed into it—then nearly filled with pure water and hermetically sealed—a mark was made where the water stood and then a voltaic battery applied—decomposition took place, gas was formed which ascended to the top and accumulating produced after some day[s] great pressure—after some time so much water had disappeared as would perhaps occupy about $\frac{1}{3}$ of the space previously occupied by air—so that the pressure was probably very great. In this state of things a fresh battery put to work—liberated but very little gas, apparently from its compressed state—but certain other appearances took place—the cloud of minute bubbles seemed to me to dissolve in the water as they left the wire, only a few reaching the top—and the quantity of water appears not to be diminished by the last two or three day's voltaic action, as if it were recomposed from the dissolved gases or at least formed a solution equal in bulk—still a few small bubbles rose. After a time a remarkable appearance was seen between the wires; bubbles were seen to pass backwards and forwards between the wires as they ascended from bottom to top as if attracted and repelled alternately—they seemed however to be carried by and influenced merely by the motion of the surrounding water. Some little filaments were now observed inside and these by their motion shewed the water about the wire to be in rapid motion—they went backwards and forwards rapidly between the wires just as the bubbles had done.

VOLTAIC DECOMP.
OF WATER IN CLOSE
VESSELS.



After a further action the quantity of gas evolved was very small, but looking through the tube when the sun shone on it,

VOLTAIC DECOMP.
OF WATER IN CLOSE
VESSELS.



rapid currents could readily be seen between the two wires, moving quite horizontally. Sometimes these seemed to consist of a stream of very minute bubbles principally on the negative side, passing to the positive side, embracing the wire as it were and then moving up it, partly I think disappearing, partly forming bubbles somewhat larger which rose to the top. At other times and most generally at last the currents seemed to be visible merely from difference of refractive power, as if they were solutions (perhaps of gas) and these passed from the negative to the positive pole and from the positive also to the negative; the currents were as in the margin—generally from N to pos. at top, from *p* to neg. a little lower down—this probably from some casually [?] arrangement of the wire—they ceased to be visible the moment the contact was broken and recommenced the instant it was renewed—they went directly across the tube from wire to wire—and were evidently the result of strong attractions and repulsions—they formed returning currents in the part of the tube on their sides, but these were not visible except when a little bit of floating substance came into that part.

The motions seem to me to be produced by the attractions and repulsions of electrified water or solution—to be visible probably in consequence of solutions of the elements at the poles in water being formed—and also in consequence of the non formation of gas which in its ascent would disturb them—and it seems also as if the decomposition of the water was limited—perhaps because under such pressure solution of oxygen and hydrogen may form water by contact, especial[ly] when the mixture is in certain relative situations to one or the other pole. These repulsions, etc. appear to me to be the same as the motion of mercury observed by Sir H. Davy.

1825. APRIL 14TH.

CONCENTRIC
LAYERS IN CRYST.
NODULES.

Illustrate concentric layers in nodules as of fluor spar by the similar crystallization of crystalline substance from oil of pepper-mint on surface of glass. It commences at a centre, stops for an instant, a second layer or ring shoots out—it stops short, then a third is formed, and so on to 20 or 30—the crystallization ceases

apparently from a portion of latent heat evolved which when dissipated permits the process to go on again, etc.

Protoxalate of mercury, a white powder, insoluble, etc. when dry, detonates by heat and strongly too if wrapped up in platina foil—it also explodes though with difficulty when struck with a hammer. During explosion it is resolved into carbonic acid and mercury.

EXPTS. ON
OXALATES.

Oxalate of lime dry in M. A. Gas in retort—no direct absorption, ultimately a little—no decomposition of oxalate apparently—heat applied to the retort—water formed which sublimed—afterwards on examining gas contained Mur. acid gas and apparently common air, but no carb. oxide and apparently no carb. acid. This result singular; must repeat experiment.

Dry oxalate of zinc in M. A. Gas—much absorption—much heat evolved—left all night, absorption continued and a little air entered—April 15th examined—some of gas expelled—principally M. A. Gas—little nitrogen—no gas expelled from the oxalate—neither carb. oxide or acid.

Substance dry and hard—white—retort dry—a little of it exposed to air—rapidly absorbed moisture—taste very strong like chloride of zinc with acidity—in water became white, an insoluble substance forming apparently—filtered with difficulty—by standing separated from the clear solution—the insoluble portion oxalate of zinc and soluble in excess of M. A.—the solution acid and consisting of M. Acid holding a little oxalate of zinc in solution.

A portion of the solid matter put into a tube and heated—much M. A. Gas evolved—some oxalic acid volatilized—a little water rose—the solid matter then fused—other gas than M. A. gas came off, a fixed grey substance remained, whilst a little volatile matter rose, liquid and clear whilst hot—solidify on cooling—it was chloride of zinc and the solid matter in water gave sol. chloride zinc, leaving a grey deposit which acted on by M. A. gave mur. zinc and left a little charcoal—it evolved a little hydrogen during solution.

1825. APRIL 15.

A portion of the same substance distilled in tube retort gave off at first M. A. Gas and afterwards a mixture of Carbonic Oxide and acid with but little M. A. Gas.

It seems therefore that a compound containing oxalic acid,

EXPTS. ON OXALATES. oxide of zinc and M. A. may exist which is decomposed by heat, etc., water taking the M. A. and leaving the oxalate, etc.—try ether on it.

Quadroxalate of potassa heated—water flies off—also oxalic acid—the salt still retains water—not a dry salt—then it decomposes as do the other salts.

1825. APRIL 20TH.

Oxalate of lime in M. A. G.—no action without heat, then formation of water—of chloride of lime—deposition of a little charcoal and evolution of a mixture of Carbonic oxide and carbonic acid and I think a little hydrogen—nothing particular in the results.

Oxalic acid heated on pulverised antimony—no particular increase of decomposing power.

Oxalic acid in sunshine alone—nothing particular.

” ” ” mixed with platina—nothing particular.

1825. APRIL 16TH.

CRYSTAL FROM MARSH. Crystal from Marsh at Woolwich. His letter says it was taken out of a piece of chalk.

Was a single piece weight about $\frac{2}{3}$ of a grain—colourless—transparent—sinking in water—easily broken or crushed to powder—fracture vitreous, not crystalline cleavage—alkaline to the taste—alkaline to turmeric paper—had exactly the appearance of a piece of washed bi carb. potash—but did not break like it with cleavage fracture.

Dissolves in water—solution alkaline to turmeric and litmus paper—aqueous solution on glass plate and warmed to evaporate left the spot covered by a colourless transparent film like a varnish—edges thicker than the rest and where thickest white and opaque as if it had split in various directions—by glass the white part did not seem crystalline—the whole hard and scratching by a knife into powder as if it were a resin—this was the case when cold—when heated the same—except that slight cracks appeared across the film on the plate like the cracks of varnish—a considerable heat did not disturb the transparency—it scraped brittle like a dry varnish. Water added to it dissolved it entirely—the solution

alkaline as before—on reevaporation the same transparent varnish appearance as before—this film left exposed to air.

CRYSTAL FROM
MARSH.

A drop of the aqueous solution on a glass plate left to spontaneous evaporation.

To aqueous solution added nit. silver—cloudy precipitate—resoluble by adding little dilute N. A. to neutralise alkali—not therefore due to M. A.

To aqueous solution added Mur. baryta—flocculent precipitate—little nitric acid redissolved it—no sulphuric acid therefore—ammonia added to this solution caused no precipitate—no phosphoric acid therefore—nor can ammonia set the alkali or other substance free from the N. A. or restore the former state of things.

Aqueous solution: same action with lime as to first precipitate from muriate.

Aqueous solution with Mur. Platinum.

Aqueous solution neutralises acids as shewn by effect on red-dened litmus paper.

A portion of the crystal dropped into a drop of M. Acid on a glass plate—no effervescence—crystal became white—broken up by a glass rod—would not dissolve—added water, then dissolved readily—solution evaporated on the plate by warm stove left crystals on the spot—needles, etc.—these soluble in water—neutral—did not precipitate mur. lime—hence no phosphoric acid present—a very little phos. soda added gave abundant precipitate with the previously added lime.

Some Mur. acid diluted—piece of bi carb. potash dropped in, abundant effervescence—a piece of the crystal put into same acid—no effervescence; certainly no carb. acid present.

No change in the crystal by exposure to air for 2 days—from April 14th to April 16th.

Heated in tube—much water given off—substance became white, pulverulent—swelled—heated more highly, fused into a colourless liquid when hot, a colourless glass when cold—dissolves slowly in water and gives former solution.

Tried it for Boracic acid. Might be Sub borate of Soda. Solution of borax gave similar indications with test—dissolved piece of crystal in water, added a little Sul. acid until slightly

CRYSTAL FROM acid—evaporated nearly to dryness—then added a little alcohol—
MARSH. stirred it, heated and inflamed it and obtained green flame.

Specimen is a piece of Borax—has not come from the chalk—but has either accidentally been supposed to do so—or has been mischievously described as having such a source with intent to deceive.

Boracic acid readily distinguished from Phosphoric acid by none precipitation on adding ammonia to solution containing it and Mur. baryta with little N. A. and by green flame as above.

1825. APRIL 20, 21, ETC.

ELECTRIC POWER
OF OXALATE LIME.

Electric powers of Oxalate of lime.

Some oxalate of lime dried in a wedgewood's basin—when found by cold glass plate that no more moisture came off, it was found that when stirred with a platina spatula it became strongly electrical, so that from the mutual repulsion of its particles it flew about the capsule and even out of it when moved and could not be brought together. When stirred by the spatula or a glass rod or otherwise the particles rose up from the spot stirred in a vivid fountain.

The particles could be rendered electrical either [in] a wedgewood, a glass or a silver dish and when stirred by glass or metal.

The electrified particles were attracted by conducting bodies brought near to them.

The oxalate was electrified in this way by stirring as well or even better when cold than when hot, so that they had not been exposed to the air or moisture—by exposure to air the oxalate soon attracted a portion of water and lost the power of becoming thus electric by stirring—exposure to moderated temperature drove off this water and the oxalate resumed its powers.

Oxalate of lime dry a very bad conductor of electricity—seems a perfect insulation—when stirred by a metal rod or spatula it clusters round it, being attracted, and yet cannot discharge itself, but if shaken off on to electrometer renders it highly electrical.

Electric state results from friction of the oxalate of lime against the metal or glass.

Platina spatula insulated on wax, then rubbed against the dry oxalate in porcelain basin until the oxalate electrical; afterwards

put in contact with the Electrometer cap and caused divergence of leaves by *Neg.* electricity.

ELECTRIC POWER
OF OXALATE LIME.

Portions of the oxalate clung to the spatula; these shaken off on to the cap of the electrometer caused divergence of the leaves with *Pos.* Electricity. The divergence was above 2 inches in certain cases.

A jar was charged *pos.* and its nob brought near the electrified oxalate in the basin—the oxalate was repelled. The jar charged *negatively* attracted the oxalate—hence it was *Pos.*

A portion of dry oxalate put on cap of electrometer and rubbed with an agate pestel—it adhered to the pestle, leaving the brass so that the surfaces rubbed were the brass of the cap and the surface of the oxalate (caked) collected on the pestel. When rubbed together the electrometer became strongly electrical—*Neg.*—and as on bring[ing] the surface of oxalate towards it the divergence diminished the oxalate must have been *pos.*

Oxalate in silver capsule on Electrometer cap—stirred by insulated plat. spatula—capsule and spatula both *Neg.*—substance flew to either, being in the opposite state.

Oxalate of lime in glass capsule rubbed by glass rod—strongly electrical—attracted by rod—shaken on to electrometer—oxalate was *pos.*—glass *neg.*, glass capsule also *neg.*

Oxalate of lime seems more *pos.* by friction than any other substance.

Oxalate of zinc—none of these effects.

„ lead—none of them.

1825. APRIL 26TH.

Liquor from condensed Oil gas sent to me by Mr. Gordon.

CONDENSED OIL
GAS LIQUID.

Very limpid—liquid—odorous—peculiar reflection of colour at surface like quina sols. with alkali—when opened tension of vapour so strong as to cause constant emission from the bottle, and rapid descending current[s] were seen in the liquid from the cooling process at its surface by evaporation—vapour very combustible—flame bright—depositing fuliginous particles—odour that belonging to oil gas—the substance not acid to litmus.

Distilled a portion—condensing in tubes or bottles cooled to 0° F. Portion I, such as came over, retort merely warmed by

CONDENSED OIL
GAS LIQUID.

air or hand—II, another similar portion—III, another portion, retort warmed now and then by spirit lamp—IV, heat increased and continued—V, heat still higher—VI, heat very considerable, probably 300° or more. Portions I and II small—III a little more—IV and VI most abundant—V moderate—these all colourless and transparent—residum dark coloured poured into capsule—very combustible—like oil partial[ly] altered—as in sugar house expts. by heat—(high), boiled it off leaving a black carbonaceous residuum.

LIQUIDS FROM OIL
GAS LIQUOR.

No. I colourless—transparent—limpid—by temp. of 0° slight deposit of solid matter disappearing again as temp. raised—tube opened over mercury gave Vapour—permanent at common temperatures—quite as other gases—odour of oil gas—at 0° condenses into fluid again—also in part at 32° under pressure of 12 inches mercury added to atmosphere—its flame very bright—when aperture of tube opened the vapour burnt in a constant jet as a safe vapour lamp—fluid highly refractive.

APRIL 27.

Bent tube filled with mercury over trough.

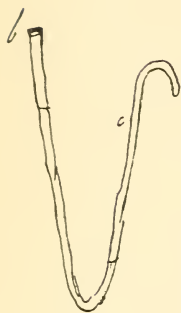
No. I taken and distilled by heat of air into tube, its vapour passing into the tube as gas—appeared as a gas over the mercury—the gas as it issued from the tube I heavy and highly refractive—visible as it passed through the air. The gas in the tube had the part *a* cooled to 0° , the mercury being also cooled—it entirely condensed into liquid even when mercury in leg *b* was 6 inches lower than in leg *c*.

Being put into a bath of water the liquid at 32° supported only a very short column of mercury (about $\frac{1}{4}$ inch) in addition to the pressure of the atmosphere (bar. 29.3 inches).

At 40° it supported 1.5 inches of mercury.

At 50° „ „ 3 inches Do.

It was found useless however to go on because the vapour was evidently a mixture of substances of different elasticity—at 50° for instance, adding 3 inches more of mercury though it compressed the gas and condensed a small portion of it, yet it did not condense the whole, so that at 50° it seemed either to support 3 inches or 6 inches at pleasure.



Substance evidently a mixture—the more volatile raising in vapour and the less volatile evidently condensing the more volatile at temperatures when, if alone, it would be permanently elastic. The whole however almost condensable at 0° with pressure of not more than 24 inches mercury—and also condensible entirely at 32° with pressure of 30 inches mercury.

To ascertain the S. G. of vapour a tube prepared—weighed 16 gr.—distilled a little of I (a fresh portion) at low temp. condensing at 0° into it and then drew it off and sealed at *a*—piece drawn off weighed 5.76 gr.—hence tube containing liquid weighed 10.24 gr.—with the liquor it weighed 12.42—hence fluid equalled 2.18 gr. This put into a jar over the mercury trough and the tip broken off—gas rushed out into the jar—a portion of liquid remaining—in an hour this had much diminished—after 4 hours a little remained in bottom of tube—this evidently proves that fluid a mixture of substances of different volatility—left all night over the mercurial trough.

LIQUIDS FROM OIL
GAS LIQUOR.

S. G. OF MOST VOL.
PART.



APRIL 28TH.

This morning still a little liquid left not volatile at 50° at pressure of atmosphere—gas equalled 3.4 c : i : at 54° —or 100 c : i : = 64.12 gr., or S. G. to hydrogen 30.24.

An equal bulk of water to the liquid used weighed 3.48 grains, hence S. G. 0.627 at 54° .

This gas or vapour transferred to water trough—mixed with chlorine, immediate condensation (very rapid), much heat evolved—and a fluid formed which in taste, smell and appearance exactly resembled hydro chloride of carbon—absorption of chlorine and gas almost total—combining volumes apparently 1 of gas, $1\frac{1}{2}$ of chlorine.

IT AND CHLORINE.

Gas agitated over water; 60 vols. quickly became 40 vols.—the 40 permanent, probably vapour of a more volatile substance than the 20 absorbed.

Gas readily soluble in alcohol—water added to alcoholic solution causes rapid effervescence and liberation of much gas, burning with bright flame—the part liberated probably more vol. than part remaining in solution—alcoholic solution burns with pale flame—is perfectly neutral to test papers—has a peculiar hot taste.

MOST VOLATILE
VAPOUR—WITH
ALCOHOL AND
WATER.

MOST VOLATILE
VAPOUR—WITH M. A.
—SUL. ACID—
POTASSA.

Sol. pure potassa (strong); no action on gas or even the liquid at common temperatures.

Sul. acid let up to gas absorbed very large quantities of it—became brown—no residuary gas—heat evolved—on adding water no liberation of gas of any kind—a slight opalescence produced—then added ammonia in excess, still no liberation of gas.

Mur. acid in sol. no effect on gas—added sol. per sul. iron and agitated—apparently much action, became black, etc., but no diminution of volume until afterwards agitated with much water, then diminished about one half—residuary gas burnt with bright flame.

1825. MAY 2.

LIQUIDS AND
SUL. ACID.

Worked with the portions obtained April 26th.

No. VI the most fixed; evaporates in the air with much rapidity—some put into a capsule and exposed to the air at 3 o'clk. had nearly disappeared at $\frac{1}{2}$ past 5—still last portions not so volatile as the first.

No. I. Sulphuric acid introduced into the tube—a little caused much blackening—heat—and a separation into two portions, one black and thick, the other colourless nearly and more fluid—the latter found to be combustible—odorous—mixing with fresh S. A. but not blackening—on adding water separating from the acid again.

More S. A. introduced into the tube—still not mix with the *whole*, a little left clear—heat evolved during action but no gas—applied a little more heat—then sudden liberation of gas—incombustible—odour of Suls. acid—this soon ceased and then substance in tube black and nearly solid—further heat evolved a little more gas from action of the charcoal on the S. A.—water added—filtered—solution acid and dark—the black charry substance—pulverulent—burning with flame—little odour of sul. acid—burns away entirely—in Alcohol gives coloured solution containing but little solid matter.

No. V. Blackens with S. A. immediately—much heat—the whole apparently acted upon if S. A. enough.

When a little was put into much Sul. acid—at first brown emulsion—on adding water a kind of precipitation occurs and the

whole assumes a violet tint—more water changes the colour and on standing a blackish oil floats—very odorous—and a dirty aqueous solution separates. This oil is sol. in S. A. if strong, giving a brown solution which on adding water yields the violet tint again—it may be retained violet if in acid of a certain strength—it is rather tenaceous after this second precipitation—heavier than water—does not seem *very combustible*—changes effected apparently by continued action of S. A. on it—it does not seem very volatile by heat—but is decomposed by it.

LIQUIDS AND
SUL. ACID.

Purple oil in No. V dissolved, forming a green solution. Alcohol added dissolved both—and the solution by water gave greenish white precipitate. Purple oil in Alcohol gradually became stiffer, a greenish substance (pasty) remaining and a colourless solution resulting which by water was white. The green residuum very soluble in No. V.

No. II. Very Volatile—a good lamp at 50° —added to S. A. much action—much heat—no gas—black mixture—this to water gave greenish grey or black precipitate, not purple.

Olefl. gas over S. A. over Mercury: no immediate absorption, blackening or change of any kind.

Alcohol dissolves all the volatile substances from oil gas.

Vol. Oils dissolve V, absorb vapour of I rapidly and abundantly.

Fixed oils Do.

Do.

1825. MAY 3.

Sulphuric acid with either I or V—first action by heat evolves only Suls. acid—no carbonic acid or oxygen—action seems to depend on the hydrogen of the compound taking oxygen from the sulphuric acid and carbon being deposited.

LIQUIDS WITH S. A.

Ether dissolves V readily, solution burning with bright, smoky flame—a very little ether condenses many vols. of I vapour.

Alkaline sol. of potash does not sensibly dissolve V nor does it dissolve any vapour of I.

Nitric acid on IV in basin—not much action—gradually browning—on IV in tube by agitation gradually became brown and hot—on applying heat nitrous acid came off mixed with brightly combustible vapour—after a time water added—the re-

WITH N. ACID.

WITH N. ACID. maining portion of oil slightly heavier than water—of a pungent odour and affecting the eyes somewhat.

OLEFT. GAS AND ALCOHOL. *Alcohol* not very strong (S. G.) dissolves about $1\frac{1}{2}$ vols. of olefiant gas at 60° , not much more at 0° —perhaps 2 vols. or a little more—the solution mixed with water evolves about half the gas again. It appeared to me that on adding about a vol. of alcohol to 6 or 7 vols. of Oleft. gas it dissolved more gas than a second vol. of alcohol did upon being afterwards added, as if the first alcohol had acted upon a more soluble portion—try this again.

1825. MAY 5.

MOST VOLATILE
VAPOUR WITH
SUL. ACID.

About 16 vols. oleft. gas from Alcohol have been left with one vol. Sul. acid over mercury in a tube for 2 days—the gas has gradually diminished and now only about 4 vols. remain—the sulphuric acid has become yellow in colour—but not black—no charcoal deposited—the gas remaining burnt with a pale blue flame like carb. oxide or light hydrocarbonate or little olefiant gas with much air—no sulphurous acid formed—no odour of it in Sul. acid when heated even—except up to a certain point when suls. acid was developed and charcoal also, colouring the liquor black. The substance is apparently a compound of sulphuric acid and olefiant gas—probably sulphovinous [?] acid—must prepare more in a retort and examine it for that acid.

Expts. on action of S. A. on mixtures of vapour 1 or 2 with air or gas.

Vapour acted on by S. A. nearly all absorbed—a little air perhaps from the water it has stood over.

1 vol. vapour + 3 vols. air—the 1 vol. completely and readily separated by about $\frac{1}{4}$ vol. Sul. acid—none left.

1 vol. vapour + 7 Oleft. gas—added about $\frac{1}{3}$ vol. Sul. acid—browning and on agitation immediate absorption of nearly 1 vol. —on further agitation for 5 minutes about $1\frac{1}{3}$ vol. had been absorbed on the whole—no vapour remained, only oleft. gas.

COAL GAS WITH S. A. 8 vols. of Oleft. gas alone, added $\frac{1}{3}$ vol. S. A.—agitated for a minute—doubtful if any absorption—hence may separate vapour very well by S. A. from Oleft. gas or from oil or coal gas—left till the morrow, then about 2 vol. of Oleft. gas had combined with the sul. acid.

34 vols. of coal gas from Fisher's shop with about 2 vols. of COAL GAS WITH S. A.
 Sul. acid—apparently absorption of about 1 vol. or $\frac{1}{34}$ part—sul.
 acid brownish—left till the morrow—but the result doubtful: try
 it again.

Strong sol. potash has no action upon these rectified vol. pro- LIQUIDS WITH
 ducts—this a strong distinction between them and common oil. POTASH.

MAY 9TH.

A piece of solid potash into IV soon became yellow brown—
 next morning black—gradually chars and decomposes the sub-
 stance.

Sul. acid heated in Olefiant gas—became black and charry— OLEF. GAS, S. A.
 vapours formed—absorption took place—suls. acid was produced AND HEAT.
 —and this absorbed over water left about $\frac{1}{3}$ of the original volume
 of a gas—combustible with a pale blue flame and apparently light
 hydro carbonate.

Went to Day to Portable Gas works. Saw Mr. Gordon and ARRANGEMENTS AT
 the Arrangements. PORTABLE GAS
 WORKS.

Mr. Turnbull, Engineer.

Mr. Hasledon—Superintends the filling, etc.

Make from 70 to 90 c. feet of gas per Gallon of oil.

Water in oil interferes very much.

Gas varies much with the oil, heat, etc.

Mr. Gordon has known of the condensed liquor 4 or 5 years.

Has obtained a fluid from coal gas condensed.

Pressure at works 30 atmospheres.

Heat evolved during condensation.

1st General recipient a fixture; fluid drawn off from it.

Lamp vessels screwed on to pipes and are moveable.

When communication opened to them from recipient, sudden
 cold produced so as in winter to produce frost on outside of lamp
 vessels at bottom.

During condensation much heat at *top* of lamp vessels, up to
 100° sometimes; always hottest above, difference sometimes 32°
 to 100°.

Pressure in vessel at first 30 atmospheres; by standing reduced

ARRANGEMENTS AT
PORTABLE GAS
WORKS.

to 27·28 and even to 25 atmospheres. This probably from condensation of fluid in vessel as temperature falls.

A large lamp vessel at 30 atmospheres—left a while—then gas let out suddenly—till all at common pressure—closed and left for some time—vapour, etc., arose up to pressure of $4\frac{1}{2}$ atmospheres.

Has not been observed higher than this.

COAL GAS WITH S. A.

Coal gas in a tube with Sul. acid over mercury became brownish immediately and slight absorption took place. On May 13. No increase of absorption last days; on estimating vols. it was found that 257·1 vol. coal gas had been used, 6·9 vols. Sul. A., and the absorption was 6·6 vols. Bar. and thermometer attended to.

OLEFT. GAS WITH S. A.

A retort capped and exhausted by air pump held 44 c:i: of gas—introduced 1 c:i: of sul. acid, then filled it with Oleft. gas and left it in laboratory light. May 10—7 c:i: of oleft. gas entered—put it into sun light.

May 11. 10 c:i: oleft. gas entered—put it into moderate day light.

„ 12. 7 c:i: Do. — „ „ dull day light.

MAY 11, 1825.

MOST VOLATILE
VAPOUR WITH AL-
COHOL AND WATER.

110 parts (vols.) volatile oil vapour— $5\frac{1}{5}$ vols. alcohol (S. G.) absorbed the whole— $5\frac{1}{5}$ water added evolved about 70 vols. vapour— $5\frac{1}{5}$ vols. more of alcohol absorbed till about 30 vols. left.

Added alcohol till all dissolved—then nearly its vol. of water—about half the vapour evolved—this dried, etc., when treated over mercury by S. A. absorbed readily—whitish precipitate formed—no gas or at least very little produced—no Suls. acid formed—on adding water precipitate became white—when settled, small in quantity—slightly examined—part of it apparently sul. mercury—but some of it sol. in Alcohol—not in Alkali and not changing colour in alkali as salts of mercury would.

WITH S. A.

Much vapour added to little S. A.—great absorption—browning but no gas—no suls. acid formed—diluted thick brown acid with water—peculiar odour—added cream of lime—filtered—added carb. acid—filtered—obtained clear solution. To a part added baryta water—filtered—evaporated to dryness—became brownish—washed with N. A. to dissolve carbonate formed from excess baryta and found sulphate of baryta present—this in favour of sul. vinous acid.

The other part evaporated for salt of lime—then redissolved in

Alcohol, filtered and evaporated—a salt obtain[ed]—deliquescent—very sol. in alcohol—neutral but bitter—crystalline—when heated—melting—drying—burning with flame—evolving suls. acid and leaving acid sul. lime if not too much heated. Agrees with Sulphovinate except in taste. Cannot be hyposulphite from resisting action of heat more—deliquescent in moist atmosphere, dries in dry atmosphere—S. A. appears to displace acid.

To about 30 vols. of Oleft. gas added 1 vol. liquid No. IV—it at first diminished the vol. of gas by absorption—but soon caused expansion by adding vapour, the expansion being about $1\frac{1}{4}$ vols.—removing the fluid by paper and then adding S. A. to absorb vapour in Oleft. gas $5\frac{1}{2}$ vols. disappeared. Now $5\frac{1}{2} - 1\frac{1}{4} = 4\frac{1}{4}$, which is about the bulk of Oleft. gas absorbed by the 1 vol. of No. IV.

SOLUBILITY OF
OLEFT. GAS IN
LIQUIDS.

1825. MAY 12.

At Apothecaries' Hall. Their oil gas apparatus.

Besides liquor which condenses in oil can—some condenses on water in Gazometer—some in the syphon tube at lowest part of pipe from gasometer to the retorts—black, dirty—odour of oil gas.

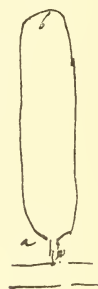
Hennel will send me a portion of that and a portion which they distilled some time since in a common glass retort and receiver. This substance passed through a[n] extra heated retort deposits carbon and forms gas, etc.

HENNEL'S GAS
PRODUCTS.

At Portable gas works again—they were filling the recipients. Had occasion to observe that on letting gas compressed to 30 atmospheres into a tall recipient, by which expansion it came down to 10 atmospheres, that at *a* the temperature fell and at *b* rose; the cooling at *a* depending upon the expansion of the air entering, but which having taken heat is afterwards compressed at *b* by the successive portion of air and a portion of the heat evolved again, so that the heat is actually carried from *a* to *b*.

Having a well stoppered bottle—the aperture at bottom of the condenser was opened—at first much water came out which foamed something like champagne from evolution of gas, but it soon became clear. Then liquor flowed out into the bottle—came out pretty clear and not as I expected frothing or boiling much—it was easily put into the bottle and easily retained there by a

AT PORTABLE GAS
WORKS—LIQUID
COLLECTED—PECU-
LIAR EFFECT.



AT PORTABLE GAS
WORKS—LIQUID
COLLECTED—PECU-
LIAR EFFECT.

finger on the stopper—its vapour had not great tension though it was drawn when a pressure of about 20 atmospheres was within—this seems to indicate that the liquor contained nothing very volatile because there was nothing of the kind in the gas which was condensible—it puts a limit to the volatility of these condensible matters, probably 3 or 4 atmospheres, and distinguishes them by a long interval from the gas remaining not condensible at 30 atmospheres. The bottle was carried home safely and without any difficulty.

Brought away a bottle full of oil gas also for examination.

TENSION OF MOST
VOLATILE PART.

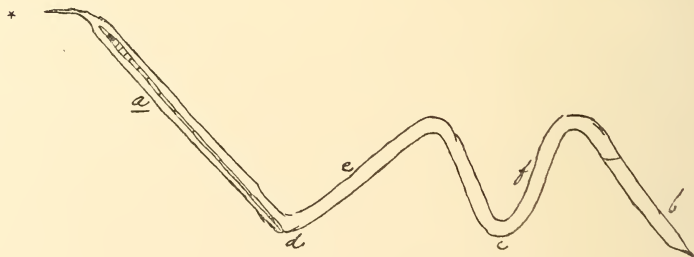
Distilled a portion of this fresh liquor into glass tubes cooled to 10° , 0° , etc.—the very vol. portion seems to be in small quantity. With the first portions there always comes over a part condensible by 0° into a solid form—it is then white, pulverulent and looks a little like hoar frost—it melts and volatilizes at a little elevation of temperature—it sometimes stops up the end of my drawn out retort. It must be a peculiar substance.

One of the first portions was obtained in a tube like the above* which was afterward sealed, air having been previously excluded by the vapour of the substance. The tube contained a condensing guage at *a* and when by inclining it all the liquid was collected in *b* it occupied about $\frac{2}{3}$ of it. The parts *e* and *f* were at such angles (as in the sketch) that on raising the end *a* any liquid in *d* could be made to pass into *c* without going back as far as *a*.

ELASTICITY OF
MOST VOL.
PORTION.

All the liquid being at *b* the pressure on the guage at common temperatures was about . The air in the guage equalled 12 parts and in this case it stood at . Then putting *c* and *d* into a mixture at about 10° and *b* left in the air or warmed by the hand—the most vol. portion distilled over into *c*; when about $\frac{1}{6}$ had come over *d* only was left in the mixture and *c* brought into the atmosphere—a second distillation took place and a portion of the most volatile passed into *d*—*d*, or the whole tube being then raised to certain temperatures the pressure on the guage was noted. At a temp. of 11° the mercury stood at about 6 of the guage = 2 atmospheres—at 60° the mercury was at 2.8, rather more than 4 atmospheres.

These pressures soon diminished from reabsorption of most



volatile by more fixed portions and consequent diminution of Elasticity. Sometimes preserved *b* and *c* warm to diminish their solvent power.

ELASTICITY OF
MOST VOL.
PORTION.

Sul. acid on glass rod a test of the presence of these vapours.

If condensing vessels not very cold and even then, may weaken instead of strengthening by distillation.

The largest part by far of vapour of oil gas is evidently a liquid at even less than one atmosphere.

1825. MAY 13TH.

Expts. with yesterday's tube and guage; distilled at temp. of 0°; at temp. of 11° guage stood at 6.75. Afterwards mercury out of order and would not traverse.

TENSION OF MOST
VOLATILE PART.

When fluid rectified from *b* to *c* the portion in *c* poured back on to that in *b* floated on it, being much lighter—if shaken the difference of S. G. seen during mixture by the different stræ.

A portion of liquid as from the works yesterday weighed out, then heated to the boiling point in glass vessel and at intervals the boiling point and loss of weight noted—boiled at first by the heat of the hand.

PROPORTIONS
EXISTING IN THE
ORIGINAL LIQUID.

				again			
grains				gr.			
	125 ..	58° lost	0	90 at ..	58° lost	0	
became	121 ..	70° ..	4.0 .. 4	70 ..	1	.. 1	
	119 ..	80° ..	6.0 .. 2	80 ..	3	.. 2	
		90° ..	8.5 .. 2.5	90 ..	4.7	.. 1.7	
		100° ..	10.4 .. 1.9	100 ..	6.9	.. 2.2	
		110° ..	14.5 .. 4.1	110 ..	9.1	.. 2.2	
		120° ..	18.0 .. 3.5	120 ..	11.9	.. 2.8	
		130° ..	22.0 .. 4.0	then boiled over—raised it to			
		140° ..	25.0 .. 3.0	130°—during conversation it			
		150° ..	29.6 .. 4.6	cooled; when weighed it			
		160° ..	34.0 .. 4.4	= 68 gr.			
then boiled over but on weighing there was				68 ..	130 ..	.. 2.6	
	72 at	160° ..		140 ..	2.6	.. 1.4	
		170 ..	5 .. 5	150 ..	4	.. 2.5	
		180 ..	17 .. 12	160 ..	6.5	.. 3.1	
		190 ..	35 .. 18	170 ..	9.6	.. 12.4	
then much went off before it got near 200°, but it suddenly inflamed and the result was lost.				180 ..	22	.. 19	
				190 ..	41	.. 13	
				200 ..	54	.. 6	
				210 ..	60	.. 3	
				220 ..	63	.. 1	
				230 ..	64		
				all volatile	250 ..	with crackling	
						noise but no charring.	

VAPOURS, OIL GAS, 211 vols. of oil gas from Gazometer at Sutton Street with
ETC. WITH S. A. about 7 vols. of Sul. Acid over mercury in a tube—by little agitation 28 vols. immediately disappeared—in 5 minutes became 38 vols.—in about 6 hours diminish[ed] to 43 vols. Supposing the Oleft. gas so diluted with hydrogen, etc., as not to be very soluble in S. A. and to have little or no influence on the absorption, then the absorption is as 20.4 per cent for vapours.

Again 100 vols. of the oil gas and about 9 vols. of Sul. acid; by little agitation 17.5 vols. immediately disappeared, and in 6 hours it had diminished by 20 vols. Of course diminution 20 per cent.

In both cases the gas left had its illuminating power very much diminished—burning more like coal gas when in a jet than like oil gas.

1 vol No. IV thrown up into dry tube over mercury—then 1 vol. of oleft. gas (made some time since) added—on agitation about $\frac{2}{3}$ of the gas absorbed—a second vol. gas added—again absorption about $\frac{1}{2}$ of the gas—a third vol. added, still some absorption; then threw up much gas so as to fill the tube—on agitation absorption though vapour of substance must have expanded the atmosphere. Perhaps about 3 or 4 vols. of gas dissolved by the fluid.

VAPOURS OF FLUIDS
TO AIR, COAL
GAS, ETC.

Coal gas not very good, having stood over water some time—added a little of No. IV to it—it then burnt with brilliant dense flame.

Burnt a taper out in confined portion of air—added a little liquor No. IV to it over water—in a few moments so much vapour had risen as to make the mixture burn with brilliant flame from wide mouthed aperture, but scarcely burning at a narrow aperture from force of current blowing it out—the appearance of flame that of oil gas—the vol. of air not increased $\frac{1}{30}$ part at most by vapour—probably not so much—estimated only by sight.

1825. MAY 14TH.

FLUIDS AND
SUL. ACID.

On the 12th. Some S. A. in dry bottle—also a tube with a little of No. IV—action soon evident in the acid. To day appearance in bottle of black and viscid S. A. mixed with a more fluid red or purple coloured liquor and in the tube of a residue pale green

colour. On opening the bottle atmosphere acid to litmus paper, pungent smell though not of Suls. acid—but may be it mixed with odour of liquid or of evolved substances.

FLUIDS AND
SUL. ACID.

First the tube—liquor dark greenish grey colour—blackness here and there on inside of tube—smell pungent—liquid not acid—added to water and left till Monday, 16th. Had then separated and risen to the surface as a pasty brown substance mixed with water—when heated water flies off, also part of the substance which is volatile apparently like the original oil, and a black substance remains, charring by heat. S. A. dissolves the substance forming deep brown solution as it would with original substance. Alkali causes separation of the water from it and resumption of fluid appearance by the body—such is the case also when it is put on bibulous paper. Is principally the more fixed part of No. IV unaltered except by mixture with little of the volatile vapours of the bottle.



The portion in the bottle was of two kinds—one thick and dark coloured like treacle—the other more fluid, lighter and of a paler colour. They were put into a separator and left till Monday 16th. Then separated and examined.

1825. MAY 16TH.

The denser black portion thick like treacle—acid, but I think not so much as S. A.—a little water added to it mixed readily, causing olive green turbidness and making original colour disappear—by more water colour became lighter and more grey—much water produced a pale gray tint, almost white—this simply due to division of a matter which separates from the acid by water, for a portion from the bottle that had been thus diluted and left to stand from Saturday till to day had separated into 2 portions; a blackish matter had risen to the surface thicker than treacle and the greyness had nearly gone. The black substance added to S. A. dissolved, forming brown solution which by water behaved as before. Potash made the black substance more liquid, apparently by separating water.

The aqueous solution of acid being neutralised by Soda was filtered and evaporated to a certain extent, Alcohol being then added—a salt was left undissolved and one was taken up.

FLUIDS AND
SUL. ACID.

The lighter fluid was more liquid and thin—of an amethystine colour. Volatile by heat—leaving no residue except a little of the black acid which it had dissolved—not soluble in water—not very readily soluble in alcohol, but by agitation losing its colour, becoming gray and dissolving—alcoholic solution by water precipitated white—burns with bright flame—not acted upon by cold S. A. Is apparently a product of the action of S. A. on vapour of original liquor.

OIL GAS WITH S. A.

Oil gas from Apothecaries' Hall.

208 vols. with 16 vols. of S. A. over mercury—diminution in 10 minutes to 181 vols.—did not decrease perceptibly in 2 hours afterwards—there was a slight liberation of gas, apparently from action of mercury on the S. A., the mercury not being pure and being affected by the acid in other vessels.

Again, 184.5 vols. with 20 vols. S. A. diminished in 10 minutes to 157 vols.—circumstanced as above.

Again, 236.6 vols. with 6.5 vols. S. A.—in 10 minutes became 201 vols.—then as before.

RECTIFICATIONS
OF FLUIDS.

Distilled and rectified a portion of liquid from which most volatile part had been separated. Received in 3 portions, noting temp. of vapour in retort when boiling as indicative of volatility. First portion to 170°. Second to 210°. Residue above 210°.

On redistilling first portion much in it requiring heat of 200° or more for ebullition, having been carried over with volatile portion. On redistilling second portion it boiled below 170°, volatile matter having been held down in it. Observed this effect very much afterwards. After several rectifications had obtained 8 portions.

I . . .	up to . . .	140°	9	} these about the comparative quantities, no account being taken of those portions lost by volatility.
II . . .		170°	10	
III . . .		180°	8	
IV . . .		190°	10	
V . . .		200°	8	
VI . . .		210°	5	
VII . . .		220° very little then left nothing . . .	5	
VIII . . .		residue	6	

Still these indicated by their temperatures that they were mixtures, but the last portions were more steady in their temperatures than the first.

A portion of I in a tube with thermometer—when boiling at 140° not above half gone—much remained even at 170° and it rose to 180° and 190° before all was volatilised.

REPEATED RECTIFICATIONS OF FLUIDS.

Rectified I, thermometer bulb being in the liquor—about $\frac{2}{3}$ passed over by boiling below 140° , and between that and 170° nearly the other third, but a little remained even then.

V and VI mixed—then rectified—began to boil at 140° (A)—full boil at 160° —at $184^{\circ}-6^{\circ}$, a very constant point, much distilled over—at 190° about two thirds gone over. Cooled that in retort, then distilled into another receiver—heat rose to 190° again immediately and before any boiling of importance took place—between that and 200° $\frac{4}{5}$ of the remainder went over (B).

About equal parts of that (A) before 140° and of that (B) between 190° and 210° mixed and then distilled; the results came over not at 140° and 200° or thereabouts but as follows:

140°	.	.	.	.	1.5	} these being about the proportions in which they were received—of course some most volatile lost.
150°	.	.	.	.	1.5	
160°	.	.	.	.	1	
170°	.	.	.	.	1	
180°	.	.	.	.	1	
190°	.	.	.	.	0.8	
210°	.	.	.	.	0.8	

Taking the 170° and putting it into a tube with a thermometer it began to boil at 130° , and continued boiling and evaporating by 140° , 150° , 160° , 170° —by which time most was gone; but a little remained even at 180° and 185° .

Have been redistilling many times to day, separating the products at every ten degrees and condensing in vessels surrounded by ice—have of course lost much of most volatile.

The portions at low temp., i.e. 130° , 140° , 150° , seem inconstant in temperature, boiling at variable points as mixtures would do, but about 184° or 188° there seems to be a pretty constant point, and have obtained a portion of fluid which seems to boil at that temperature and not before.

Thought there was a constant point about 170° but am not certain.

A portion of that at 140° , whilst volatilizing from end of a thin tube, left a solid crystalline substance which upon slight elevation of temperature (that of the finger) instantly fused and volatilised.

RECTIFICATIONS A portion of 140° in a thin glass capsule on a mixture at 0°
(continued). evaporated, leaving solid residum very volatile—but soluble in
alcohol and precipitated white by water.

FLUIDS, ETC. WITH Three dry bottles with little S. A. at bottom; in one, I, a little
SUL. ACID. of liquid vol. at 140° and a little solution of soda, both in tubes.
In a second, II, a little of liquid at $184^{\circ}-8^{\circ}$ and also a little solution
of soda in tubes. In the third, III, a little hay in contact with the
acid.

1825. MAY 18TH.

OIL GAS WITH Mercury has been cleaned by sul. acid for 24 hours. Now no
SUL. ACID. action of the acid on it and no liberation of gas when S. A. and
oil gas put together in tubes over it—nor was any solid precipitate
formed—all that due to the impurity of the mercury. The acid in
all cases became brown.

188 vols. of Gordon's Uncondensed oil gas with 9.5 vols. of
S. A.—diminished in 8 minutes to 155—in 1 hour to 148.5—in
2 hours to 146.4.

Again 107 vols. oil gas with 13 vols. S. A.—in 8 minutes became
88.5 vols.—in 1 hour 84.5—in 2 hours 82 vols.

Again 138.5 vols. oil gas with 5.2 vols. S. A.—in 8 minutes
became 113.7 vols.—in one hour 108—in 2 hours 105.5 vols.

Hall oil gas over S. A. for 24 hours—then over water for 2 days
—144 vols. with about 60 of chlorine for a minute and the chlorine
in excess washed out left 111 of gas. Upon trial the chlorine left
about $\frac{1}{80}$ residue. The oil gas by similar agitation with water was
diminished about 4 parts in 144. The residual gas still burns with
much brightness—like bad oil gas for instance.

Gordon's oil gas from vessel (after condensation) with S. A. as
before: 211.4 vol. gas with 6.8 vols. S. A.—in 15' diminished to
183.3 vols.—in about half hour to 180.8—in 3 or 4 hours to 176.

Again 159 vols. gas with 5.9 S. A.—in 15' was at 137.5—in
half hour 136 vols.—in 3 or 4 hours 130.4.

Again 113 vols. gas with 12.2 S. A.—in 15' was 98 vols.—in
half hour 96—in 3 or 4 hours 92.

RECTIFICATIONS Have again been rectifying at boiling points— 170° sometimes
OF LIQUIDS. appears constant— 176° pretty constant— 180° very constant, large
quantities coming over without change.

On redistilling some of 170° it began to boil at 130° , boiled well at 140° , 150° —at 160° much came over, perhaps one half—a little remained at 180° and 190° . RECTIFICATIONS
OF LIQUIDS.

Again with fluid of 180° —began to boil at 160° —full boil at 170° —very little remained beyond 180° .

Finished by having portions of fluid at 140° — 150° — 160° — 170° — 176° — 180° — 184° — 6° — 190° — 200° — 210° .

Put all these in tubes into cool mixture at 0° .

140° —became slightly turbid—instantly clear by warmth of hand.

150° —Do

160° —rather more turbid—Do.

170° —As first.

○ 176° —crystals round side—fluid in middle.

180° —only little turbid like first.

○ 184° — 6° —quite solid and crystalline.

○ 190° —Do.

200° —Slightly turbid.

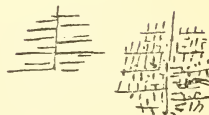
210° —Do.

On probing the three ○ with a cold glass rod, but a small quantity of solid matter was found in 176° to what there was in the other two— 176° when broken up and left to rest at 0° let the crystals fall and clear fluid floated above—when allowed to warm, crystals rapidly dissolved forming a solution—dense and lying under superior fluid. BI CARBURET OF
HYDROGEN PRO-
CURED.

184° — 6° and 190° hard like cold butter—pressed much of solid matter to bottom of the tube, then poured off part of the upper solution and thus divided it into two portions.

Crystals are white, transparent—dendritical.

Query Napthaline.



1825. MAY 19TH.

Napthaline from Coal tar boils at 420° .

To a portion of 190° added Napthaline (which dissolved readily) until the solution when cooled to 0° crystallized in part—but it did not crystallize in appearance like 186° or the others. Then heated this solution—it began to boil at 180° ; boiled on whilst heat slowly rose to 190° ; vapour then ceased to come off for a while and the thermometer rose to 300° and nearly 400° , COMPARED WITH
NAPHTHALINE.

COMPARED WITH
NAPHTHALINE.

yet boiling of the residue (the Napthaline) had not commenced—taken from the heat and cooled—when at about 60° the whole solidified into Napthaline. Hence 186° , etc. do not owe their crystallization at 0° to Napthaline.

PURIFIED.

The solid 190° of yesterday cooled to 0° in a strong glass tube—then a single thickness of dry cold bibulous paper pressed upon it by the closed end of another tube entering the first—then a crumpled pellet of bibulous paper pressed upon that, the whole being retained at 0° —in this way paper absorbed fluid portion—removed it and introduced fresh paper in the same way—this repeated till paper was no longer moistened by liquid and the solid part remaining was dry and hard—withdrew the paper—fused the solid—recrystallised it—repapered it—a little more removed but very little.

Substance now a white crystalline solid—not fuzing at 32° —fuzing at 45° —when cooled to 28° readily crystallizing—crystals dendritical—brittle at 0° —substance hard as sugar perhaps—pulverulent. As a fluid at 60° limpid, but not so much so as the liquor at 190° —boils at 186° —burns with dense white or smoky flame according to circumstances—soluble in alcohol—solution precipitated by water—is apparently very slightly soluble in water—approaches to water in fuzing and boiling points.

MAY 20TH.

BI CARBURET OF
HYDROGEN WITH
OXYGEN.

A portion of this peculiar substance put into an atmosphere of oxygen rose in vapour in sufficient quantity to make the atmosphere explosive either by taper or electric spark—could detonate it in tube.

7.32 vols. pure oxygen at 61° —admitted liquid—in 10 minutes had become 8 vols.—i.e. 7.32 oxygen + 0.68 vapour—not very accurate. Observed again—whole vol. not quite 8 and vol. of vessel and liquid introduced about 0.1—hence as oxygen 7.32 + vapour 0.58 or *oxygen* 12.62, *vapour* 1.

Of this mixture 7.5 vols. at 61° F. were detonated in Eudiometer by E. Spark and became 6.25—potash reduced this to 2.7 which was pure oxygen.

This would give if correct (but is doubtful from uncertain
vol. of vapour)

oxygen—4.25 } = 4.8 the substances acted upon, the diminution
vapour—0.55 } being 1.25—Carb. Acid—3.55
vols.

Or Vapour	1		1
Oxygen consumed	7.7272		8
Whole vol. Do.	8.7272		9
Diminution	2.2727		
Carb. acid formed.	6.4545		6
Oxygen left to form water	1.2727		2

This approximates slightly to $\begin{array}{c} c-b \\ c-b \\ c-b \end{array} \begin{array}{c} | \\ 1 \\ 1 \end{array} \begin{array}{c} b-c \\ b-c \\ b-c \end{array} = \boxed{38}$
Must be incorrect.

51 vols. pure oxygen with substance at 57° became rather more
than 56.1 = 5.1 vols. vapour or $\frac{1}{11}$.

Vapour with pure oxygen gas in bent tube—oxygen vol.
estimated at 57° F. equal to left all night.

May 21st.—Expt. continued—Jar, tube, Mercury, etc. immersed
in water at 57° F.; when of uniform temp. place of gas and vapour
marked and then a portion carefully transferred into a tube for
analysis by Eudiometer. The vols. of oxygen and *oxygen and*
vapour estimated by weight of mercury filling the space occupied.
Oxygen alone = 3617 gr. measures. Oxygen and vapour 3856.

Hence Oxygen 3617 or 15.134 }
Vapour 239 1 }

1825. MAY 21.

This mixture detonated in a Eudiometer tube—7.8 vols. became
6.5 and these by potash diminished to 3.55 of pure oxygen; hence

Vol. of Mixture 7.8
became 6.5
by potash 3.55
therefore detonated 4.25
of which oxygen 3.766549. .8
„ vapour 0.483451. .1
diminution by spark 1.30
Carb. acid produced 2.95

BI CARBURET OF
HYDROGEN WITH
OXYGEN.

Oxygen to Carbon . 2.95 3.6127 } approximates to 2
" hydrogen . 816549. . 1 } Carbon, 1 hydrogen.
The portion experimented upon must of course have contained
some of uncongealable portion boiling at 186°.

Incorrect.

BI CARBURET OF
HYDROGEN—HEAT,
POTASSIUM,
ETC. ETC.

Substance Crystallizable at 32°. Vol. at 186°.

On fusing a solid portion the solid part sinks rapidly in fluid
part, being much heavier.

A mixture of its vapour with oxygen—S. A. added over mercury
gradually absorbed the vapour of the substance and by agitation
in a minute or two the oxygen left pure and unexplosive—the
S. A. became of a pale yellow colour only—no charring.

Potassium in liquid—no action at and above boiling point;
metal bright and clean.

White heat in glass tube causes deposition of the charcoal in
part from the vapour.

Very soluble in fixed oil.

Very soluble in Alcohol and ether.

Does not conduct voltaic Electricity—is not affected by it.

The particular portion I now possess freezes as near to 32° as
may be.

WITH S. A.

A portion of liquid with about 4 vols. S. A. over mercury in a
tube—action mild—no gas evolved—no blackening—no heat ap-
parently evolved—tint light yellow of acid—and a portion of clear
colourless liquid remained floating on the acid after agitation as
if it were unacted upon by it—perhaps a product of action—about
half as much as original quantity. May 23. Added more S. A.—no
further action—remaining portion unaffected by it. The part un-
acted upon removed after some hours—was bright and clear—not
affected by water—freezing a little above 32°—then crystalline—den-
dritical—white—lighter than water—soluble in alcohol—solution at
first precipitated by water but *great* excess apparently dissolving it.

LIQUID AT 186°

WITH S. A.

Liquid boiling at 186° but not coagulable at 32° or at 0° even—
with S. A. over mercury—much action—much blackening—heat
produced—ultimately separation into two parts—the lower acid,
etc., almost black and thick—the lighter portion not acted upon
by the S. A. and of a yellow colour. May 23rd. Added more

S. A.—no apparent action after some hours—removed the portion unacted on—amber colour—lighter than water—not freezing at 10° . Sol. in Alcohol, precipitated by water—an aromatic or camphor smell and taste. LIQUID AT 186° WITH S. A.

May 21. Mixed portions boiling from 170° to 190° and fluid at 0° —distilled them slowly, fluid barely simmering—collected in two portions. About $\frac{2}{3}$ before or by 176° and the rest by 180° —these portions cooled to 0° became slightly opalescent but nothing more—both doubtless contain peculiar crystalline substance—opalescence perhaps due to a little water. FURTHER RECTIFICATIONS.

Mixed the portions from 200° to 220° and above and distilled at simmering point—gave very little at 190° —most at 200° , about one half—another portion up to 210° , about one third—a portion up to 220° , about one sixth or rather less—a little still remained in the retort. These portions appeared very constant comparatively in their boiling points—they all became slightly turbid by cooling to 0° except 190° .

The most volatile and first portions from condensed liquor cooled to 0° did not become turbid or shew signs of solidification—there appears to be a thin film of water deposited from them on the glass—soluble power perhaps being diminished by cold. MOST VOLATILE PORTIONS.

MAY 23RD.

Native Naptha and S. A. equal vols.—heat—blackening immediately—no Suls. acid—in 10 minutes separation into clear colourless Naptha and deep coloured acid—in 6 hours smell of Suls. acid. Portion unacted upon separated—added to more S. A.—little action but greater part separated—colourless—tasteless like oil—fluid at 10° in more S. A. slowly acted—slight colour. Water to the acid caused separation of part of it or something like it. S. A. AND NAPTHA.

Native oil of Laurel and S. A. equal vols.—strong action—much heat—blackening—no suls. acid—by agitation mixture soon made uniform and no appearance of separation. After some hours smell of suls. acid—little fluid had separated—thick, viscid and like castor oil in appearance—fresh acid acted slowly upon it. Water to the acid caused separation of a large portion of black oily matter lighter than water—odour aromatic. S. A. AND OIL OF LAUREL.

FLUID AT 186°.

Fluid at 0° boiling at 186°.

Boils very constantly at 186°.

S. A. on it: see May 21.

At moderate heat no change—at high heat deposition of charcoal.

Miscible with fixed oil—evaporates by degrees from it.

Admitted to oxygen—vapour sufficient to make it explosive.

Alkaline solution—no immediate action on it.

Potassium—no action upon it even when boiled.

HENNEL'S OIL GAS
FLUIDS RECTIFIED.*Hennel's rectified oil gas deposit—a liquid.*

Distilled—scarcely gave anything before 220°: then began to boil, but reached 300° before it boiled fairly—drew off two small portions and then a bottle full—a little water distilled over with it—drops in retort neck—probably gave turbidness.

Hennel's foul oil gas deposit—dark liquid.

Distilled, began to pass over at 150° in small quantity—not then boiling—boiled at 190°.

I before . . .	190°	} small quantities comparatively.
II	200°	
III	210°	
IV	220°	

V up to 280° or 290°—much above half of whole quantity.

VI last portion got up to 330° very quickly—quantity not more than IV.

Then a little left very much higher and suddenly rising in temperature. This residue partly insoluble in alcohol—the alcoholic solution in water, dark oil separated, little *heavier* than water—sol. alkali added to it mixed with it but a portion of lighter oil soon separated.

The products reduced to temp. of 0° F, No. I gave crystals of the substance contained in fluid matter. All the other became turbid only, probably from water.

COAL NAPHTHA
DISTILLED.

Hullmandel's coal tar oil.

Boils fairly at . . . 210°.

I up to 220°.

II

III 340°, a large quantity.

IV beyond 340°.

Residue black and like thin tar but quite soluble in Alcohol. COAL NAPHTHA
None of these products gave signs of substance at 0° . DISTILLED.

Vapour of 140° added to air—a portion of the mixture in a tube with olive oil—the vapour immediately taken out by agitation.

Peculiar Substance—cooled to 0° —put into bibulous paper and pressed in Bramah's press for 4 minutes—all things about it being cooled as low as possible. Succeeded in expressing more fluid from it—and obtained the substance in such a state that it now froze when tube immersed in ice cold water and began to thaw only as water gained 40° . By observing certain dendritical films on side of tube found fuzing point to be very nearly 38° F. BICARB. HYDROGEN
PURIFIED.

2 vols. of liquid at 40° became 2.25 very nearly when frozen at 32° . Diminution therefore $\frac{1}{9}$ or expansion $\frac{1}{8}$.

It may be cooled down to 30° sometimes without solidifying, but once solid fuses at 38° , etc.

1825. MAY 24.

S. G. of Peculiar body taken at Temp. 61° F.

Tube altogether weighed . . . 13.86 gr.—liquor put in then.

Piece of glass cut off . . . 9.56.

Consequently vessel remaining . . . 4.30.

Liquid, vessel and Cork . . . 26.81.

Cork . . . 21.11.

Liquid and tube therefore . . . 5.70.

therefore liquid alone . . . 1.40.

Liquid—tube and Piece . . . 15.26.

Afterwards tube filled to same height with distilled water at temp. 61° .

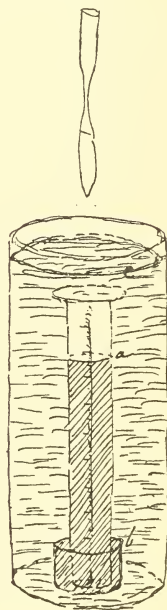
It with tube weighed . . . 5.87.

Therefore Water alone . . . 1.57.

$\frac{1.40}{1.57} = .89172$ S. G. of liquid at 61° F.

The 1.4 gr. of substance in its tube closed by a minute portion of wax was put into a jar filled with dry mercury inverted in a cup and the whole introduced into a tall glass jar. Hot water was then poured in and the temperature further raised by throwing in steam from a boiler. As the heat rose the substance became vapour. It equalled 2.2 c: i: at the temperature of 200° F., the

BI CARBURET OF
HYDROGEN: S. G. OF
FLUID AND VAPOUR.



BI CARBURET OF
HYDROGEN: S. G. OF
FLUID AND VAPOUR.

column of mercury from *a* to *b* being $4\frac{3}{8}$ inches and the column of water from *b* to *c* being 7 inches.

Barometer 29.83.

When cooled and substance had resumed liquid form only a minute bubble of air remained.

Calculation, etc.

7 inches of water = 0.5185 inches of mercury.

$4.375 - 0.5185 = 3.8565$ inches of column of mercury.

Bar. 29.83 - 3.8565 = 25.9735, pressure to which the 2.2 c:i: subject;

29.83 : 25.9735 :: 2.2 c:i: : 1.9156 c:i: vapour at 29.83 Bar.

As air at 200° air at 60° vapour at 200° vapour at 60°

134944 : 105824 :: 1.9156 : 1.5024

Hence 1.5024 c:i: weigh 1.4 gr. Bar. 29.83. Therm. 60°.

Or 100 c:i: weigh 93.1842 gr. S. G. 44.

BICARBURET OF
HYDROGEN
ANALYSED.

Some oxygen had some of the substance thrown up into it; after a while it was transferred to another vessel, no liquid passing—consequently it was a dry mixture of vapour and oxygen.

A portion of this mixture equal to 6226 gr. measures of mercury introduced into a tube over mercury, then a small quantity of olive oil sent up—absorption immediately took place and in about 40 minutes, without agitation, the bulk had become 5678 vols. Agitation and longer time did not increase this effect. Hence mixture contained

Oxygen . . . 5678 vols. . . . 10.3613 (9.4)
or

Vapour . . . 548 . . . 1. (1)

A portion of pure oxygen in another tube over mercury treated with same kind of oil for some time and in same manner—but no absorption.

A portion of above mixture introduced into detonating tube and fired by spark.

BICARBURET OF
HYDROGEN WITH
OXYGEN.

Mixture 6.48 vols.

After spark became . . 5.20

By potash diminished to 2.35 residual oxygen.

Mixture burned . . . 4.13

Vapour in it 0.5703 1)

Oxygen 3.5597 6)

Carb. acid produced . . . 2·85

Oxygen in C. A. . . . 2·85

„ to hydrogen. . . 0·7097

Dim. by spark . . . 1·28

} 4 2 Carbon 1 Hydrogen

BICARBURET OF
HYDROGEN WITH
OXYGEN.

Results not quite accordant. If 6 carbon 3 hy. in one, then C. A. underrated ·065, dim. by spark over rated ·065.

N. A. to substance—little action—reddening of acid—cold froze the substance which from nearly colourless liquid became bright red solid—colour disappeared on thawing. Acid poured off, its smell very like almonds—no prussic compound detectable by iron, etc.—substance itself then smelling like almonds—washed became clear and then white on freezing. WITH NITRIC ACID.

Sol. Potash with Substance—no evident action though temperature considerable—almond smell of substance very striking. WITH POTASH.

Carb. potash with substance—no action.

Substance and chlorine together in a dry retort—little action in common light—much in evening sun light—dense white fumes—no sensible heat—crystalline solid forming—chlorine absorbed—colour disappearing—more permitted to enter. Ultimately chlorine in excess—a solid crystalline matter something like per chloride of carbon and a fluid here and there moistening the crystals. BICARBURET OF HYDROGEN AND CHLORINE.

Opened the retort—much Mur. acid formed—blew it out—substance had an odour something resembling perchloride of carbon but more resembling artificial camphor. Put water into retort—it did not affect or dissolve crystals or liquid—hence two compounds produced. Collected the substance by spatula, having broken the retort—and pressed it between paper to remove water—paper stained as if by oil—was the fluid portion which it had in part absorbed. Paper in alcohol gave a solution precipitating white by water.

Put part of solid portion into a tube—at moderate heat it partly melted but required high heat for fusion of the whole—not particularly volatile—the heat decomposed it causing evolution of M. A. Gas and a charring of the fluid—then seemed to go on boiling unaltered—the residue when cold black and thick like treacle in appearance, and not solidifying at 60° except after some time, when it seemed full of crystals.

Heated in the air the vapour was very acrid.

BICARBURET OF
HYDROGEN AND
CHLORINE.

The rest put into alcohol did not dissolve readily—one part seemed to dissolve more readily than another—evidently two substances present—the hot alcoholic solution left to cool deposited brilliant crystals.

MAY 25TH, 1825.

The thick black substance above mentioned distilled—FIRST PORTION readily came over—was received in tube—a pale yellow fluid at 60° . *Second portion* required a higher heat—was thick—soon solidified and crystallised—a black charry mass remained which with further heat left charcoal.

Second portion—heated—volatile at high temperature, combustible on paper with much smoke—chlorine acts upon glass tube—when passed through hot tube decomposed depositing carbon and forming apparently a chlorine carbon. Glass heated in its vapour strongly acted upon—became opaque, chloride of lead formed and probably C.A. Chloride blackened by Sul. Hy. instantly.

FIRST PORTION—a mixture of solid and fluid—heated in tube—same phenomena as in former case—no chlorine liberated though glass acted upon and I think no M. A. set free—liquid produced—black—much heavier than water—not affected apparently by solution of potash or ammonia.

The tube with Alcoholic solution of yesterday. Solution poured off and evaporated—left adhesive yellow fluid not soluble in water—not affecting tongue at first but in little time very powerful, biting and persistent. Action of heat as before.

The crystals pressed in bibulous paper by Bramah—became a dry white pulverulent gritty powder—taste in alcohol nearly as last—fuzing by heat, then becoming coloured—acts on the lead in glass—passed over red hot glass—deposited charcoal but gave off no chlorine or M. A.—fumes white and acrid—it is combustible—smell of crystals something like per chloride carbon. Is comparatively difficultly soluble in cold alcohol.

MOST VOLATILE
VAPOUR WITH
OXYGEN.

A fresh portion of fluid from oil gas condenser distilled at temp. of about 70° . Vapour passed through tube at 0° or near it—the uncondensed portion received over mercury. There was not much of this uncondensed portion, and that which condensed

in the warm tube at 0° was found by after examination to have carried over a large proportion of fluid, not boiling at less than 120° or 130° . The quantity in the cooled worm was but small. MOST VOLATILE VAPOUR WITH OXYGEN.

With reference to the uncondensed vapour, a mixture of it and oxygen gas made: 1 vapour, 12 oxygen—a portion detonated in a tube.

Original vol.		9.1	
or Vapour		0.7	1 }
Oxygen		8.4	12 }
by spark became		7.3	
diminution		1.8	
by potash became		4.85	this oxygen
Carbonic acid		2.45	
Oxygen employed		3.55	
Mixture detonated		4.25	
Oxygen in C. A.		2.45	
„ to hydrogen		1.10	

Another portion of same mixture detonated.

MOST VOL. VAPOUR
ANALYSED.

{ Original vol.		12.00	
{ Vapour in it		00.92308	1 }
{ Oxygen		11.07696	12 }
By spark became		9.50	
Diminution		2.50	
By potash became		6.62	
Carb. Acid		2.88	
Oxygen employed		4.45696	
Mixture detonated		5.38004	
Oxygen in C. A.		2.88	
„ to hydrogen		1.57696	

Sul. acid added to some of this mixture—2875 vols. of mixture became 2651—hence vapour 224—this equals $\frac{1}{12.83}$ of mixture instead of $\frac{1}{13}$. WITH S. A.

Most vol. vapour in a tube over mercury. Olive oil added and agitated—dissolved about 6 times its vol. of the gas at common pressure and temperature—gave off gas under diminished pressure. There was a small residue, the whole not seeming soluble in oil. WITH OIL.

MOST VOL. VAPOUR
WITH S. A.

Most vol. vapour over mercury to S. A., the gas being introduced in 9 successive portions. The S. A. = 410 vols. and 47223 vols. of vapour were added—each addition left a residue unabsorbed by the S. A. which at last amounted to 6142 vols.—it burnt with a pale coal gas flame and was not acted upon by S. A. in half an hour. Was perhaps a product of action of acid and vapour on each other.

The S. A. at last equalled 584 vols. When put into water it became milky and an oil separated. The diluted acid was preserved for future experiments.

The S. A. would have absorbed much more vapour. It had absorbed rather more than 100 vols.

WITH IODINE.

Iodine and crystalline body at 38°. Iodine dissolves in liquid in small quantity—red fluid—put into sun light for a whole day—no apparent action.

BICARB. HYDROGEN
OVER OXIDE
COPPER.

Peculiar solid, 38°, boiling 186°—decomposed by per oxide of copper.

Tube and cork	16.13 gr.
Do. . . . and substance	17.30
Substance	1.17
Glass tube and contents	420 gr.
Do. after operation lost	4.14—then water drew off.
Do. water expelled lost	5.00 altogether— smell of substance.
Water therefore	0.86
Gas equalled	9 c: i:—correctly 8.8
Potash reduced it to	0.5 c: i:—Do.. . .47
	8.33

Carbonic acid 8.5 c: i:, portion of course remaining in the tube. The 0.5 c: i: came over early and before decomposition well commenced—it was combustible with bright flame and had smell like the substance originally.

Carb. acid produced	8.5 c: i: or 3.961 gr.
Water—by weight (expt.).	0.860
Loss in tube of C. A., etc., etc.	4.140

Hydrogen in 0.86 of water . . .	0.09555	} or {	11.305	BICARB. HYDROGEN OVER OXIDE COPPER.
Carbon in 8.5 c: i: carb. acid. . .	1.08027		1	
	<u>1.17582</u>			

Water probably dissolved some of undecomposed substance
—hence overrated—strong smell when driven off.

MAY 26TH.

Portion fluid at 0° boiling at 190° decomposed by oxide copper.				FLUID AT 190° OVER OX. COPPER.
Tube, cork, etc.	10 gr.			
Do. . . . and substance . . .	10.64			
Substance decomposed . . .	0.64			
Glass tube and contents . . .	389.88 gr.			
Lost by operation	2.28—Carb. acid.			
Water expelled—the loss . . .	0.60—Water.			
Gas received = ...	5.34 c: i: correctly—4.75			
On adding sol. potash diminished to	0.25 „ Do.		24	
Carbonic acid	5.09—graduation in—			
	correct—4.51.			
Do. . . . correct	4.51 = 0.573176 gr. carbon			
Water	0.60 = 0.06666 „ hydrogen			

Odour of substance in gas.

Portion of fluid boiling at 160°—decomposed by ox. copper.				FLUID AT 160° OVER OXIDE OF COPPER.
Cork, tube, etc.	11.9 gr.			
Do. . . . and substance . . .	12.78			
Substance decomposed . . .	0.88			
Tube and contents	359.44 gr.			
b. Lost during the operation . . .	2.82—Carb. acid, etc.			
Water driven off—loss . . .	0.80—Water.			
Gas obtained	6.36 c: i:		6.14	
„ with potash became . . .	0.23		22	
Carbonic acid produced . . .	6.13: graduation incorrect.			
a. „ „ correct vol.	5.92			
Odour of substance in gas.				
Substance decomposed	0.88			
Carb. acid gas = 5.92 c: i: =	2.86 gr. =	Carbon	0.7564	
Water = 0.8 gr. + 0.0613, diff. between a and b:	Hydrogen	0.0957		

FLUID AT 140° OVER OXIDE OF COPPER. Portion of fluid boiling at 140° decomposed by oxide copper.

Cork, tube, etc.	9.86
Do. . . and substance	10.62
Substance decomposed	0.76
Tube, ox. copper, etc.	
Lost during the operation	
Water driven off—loss	0.72
Quantity of gas obtained	5.00 c: i:
With potash became	0.23: correct
Carbonic acid produced	4.77
Substance decomposed	0.76
Carb. acid gas 4.77 c: i: = 2.2223 gr. = Carbon—	0.60645
Water = 0.72 = ...	Hydrogen—0.08

FLUID AT 150°— Fluid boiling at 150°.

OVER OXIDE OF COPPER. Cork, tube, etc. 10.24—Do. with fluid . . .	11.11
Substance	0.87
Tube and contents	362.74
Lost by heating	2.86
Water driven off	0.82
Gas received	6.21 c: i:
Potash left	0.20
Carb. acid	6.01
Substance decomposed	0.87
Carb. acid = 6.01 c: i: = 2.8 gr. = . . . Carbon	0.76381
Water 0.82 gr. = ...	Hydrogen 0.09111

AT 210°. Fluid boiling at 210°.

Cork, tube, etc. . . 10.2 Do. with substance 11.28.	
Substance	1.08
Tube, etc.	343.9
Lost by heat	3.64
Lost as water	.90
Gas received	7.84 c: i:
by potash diminished to	0.20
Carbonic acid gas	7.64
Substance decomposed	1.08
Carb. acid = 7.64 = 3.56 gr. = . . . Carbon	0.9711
Water = 0.9 gr. + 0.8	hydrogen 0.1090

Fluid boiling at 220°

AT 220°.

Cork, tube, etc.	9.76—Do. and substance—	10.73
Substance		0.97
Tube and contents		340.20
loss by heat		3.23
Water driven off		0.77
Quantity of gas		6.88 c: i:
Diminished by potash to		0.22
Carbonic acid		6.66.
Substance decomposed		0.97
Carb. acid = 6.66 c: i: = 3.1 gr. =	Carbon	0.84642
Water = .77 gr. + 0.13	Hydrogen	0.10000

Fluid boiling at 176°.

AT 176°.

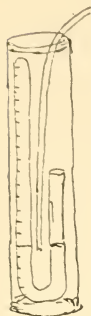
Substance		0.87
Tube and contents		356.12
by heat lost		2.91.
Water driven off		0.70
Gas received		6.20 c: i:
By potash diminished to		.23
Carb. acid		5.97
Substance decomposed		0.87
Carb. acid = 5.97 = 2.782 gr. = . .	Carbon	0.75873
Water = 0.7 + 0.128	Hydrogen	0.09200

Fluid boiling at 200°.

AT 200°.

Substance		1.2 gr.
Tube, etc.		346.96
By heat lost		4.16
Water driven off		0.98
Quantity of gas		8.96 c: i:
Left by potash		0.25
Carb. acid		8.71.
Substance		1.2
Carb. acid = 8.71 c: i: = 4.0588 = . .	Carbon	1.107
Water = 0.98 + .1012	Hydrogen	0.120

S. G. OF VAPOUR
OF SOLID AND
FLUID AT 186°.



Portions of substances converted into vapour over mercury in a syphon tube by hot water and the pressure of the mercury equalised to remove that correction—heat applied by a steam pipe.

Substance solid at 38°, boiling at 186°.

1.4 gr. in a tube introduced and heated at 212°, pressure in limbs being equal and Bar. at 29.9: the 1.4 gr. gave 19.25 divisions = 2.05 c: i:

2.05 c: i: at 212° = 1.578 c: i at 60° = in weight 1.4 gr.
Or 100 c: i: at 60 = 88.72 gr. S. G. 41.88 or 42.

Substance liquid at 0° boiling at 186°.

1.11 gr. of this body in a tube introduced. Temperature 212—the pressure on the vapour $\frac{1}{2}$ inch of mercury less than Barometer (then at 29.9) because of short open leg—the 1.11 grains gave 15 divisions = 1.6 c: i: vapour—or 1.573 c: i: corrected to Bar. at 29.9.

Now 1.573 c: i: at 212° = 1.212 c. inches at 60° = in weight 1.11 gr.
Hence 100 c: i: at 60 = 91.584 gr. S. G. 43.24.

1825. MAY 28TH.

S. G. OF MOST
VOL. VAPOUR.

Obtained more of the liquid from the works. One, the larger portion, drawn from the condenser whilst I was there at pressure of about 25 or 28 atmospheres. The other in consequence of its peculiar appearance was taken out of a carboy.

Distilled a part of the larger portion at temperatures from 32° to 60° or 70°. When the vapour was passed through a tube at 0° very little went on uncondensed to the mercurial trough. Removed the cold mixture and allowed the vapour to go on uncondensed and be received over mercury as gas.

A globe being exhausted, 39.9 c: i: of this vapour estimated at temp. of 60° and Bar. 29.94 were admitted—the globe had increased in weight 22.4 grains—hence 100 c: i: = 56.14 gr. S. G. 26.5 nearly.

Graduation incorrect: 8 c: i: only = to 7.84 c: i:; hence 39.9 = 39.102 correct or 100 c: i: = 57.54. S. G. 27.1.

MOST VOL. SOLID
SUBSTANCE.

Observed during the distillation (as before) that there is not much of most volatile products present.

Observed also the appearance of the substance which crystal-

lizes at 0° but is very fusible and volatile and which comes over almost the first thing. MOST VOL. SOLID
SUBSTANCE.

Distilled the rest of the liquor, receiving the first and most volatile into a cold tube—and then collecting a second portion—when operation ceased heat perhaps 120° —not much received compared to the quantity remaining.

MAY 30TH.

Filled a tube with olive oil over mercury and then let up a portion of most volatile vapour, the oil being half the bulk of the vapour; agitation soon caused its entire absorption. MOST VOL. VAPOUR
WITH OIL—WITH
CHLORINE.

A retort prepared—when exhausted by air pump it required 27 c: i: of air to refill it—exhausted and 20 c: i: of most volatile oil vapour let in—then added 10 c: i: of chlorine—vapour—much heat and much fluid instantly formed—all colour of chlorine gone. Admitted 10 c: i: more of chlorine—again heat produced—more fluid and colour disappeared—again 10 c: i: of chlorine—little heat, yellow colour partly remained—10 c: i: more of chlorine—deep colour, no heat—opened stop cock full and 5 c: i: more of chlorine entered.

20 c: i: oil vapour and 45 c: i: of chlorine—retort would require 27 of chlorine and vapour for its atmosphere; 18 at least therefore of chlorine combined with the 20 of oil gas vapour, or nearly equal volumes unite to form the oil.

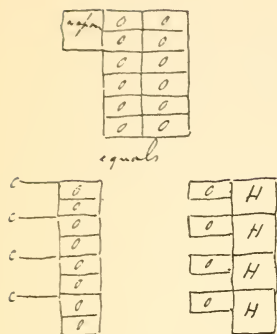
Took some of the liquid out—was yellowish from little excess of chlorine—no appearance of M. Acid in the retort—liquid had a sweet taste very like that of chloric ether but accompanied by a strong aromatic flavour like some other triple compounds of carbon, hydrogen and chlorine—this taste strongly evident even after substance had been washed by water, sol. potash and water again—it was heavier than water and burnt with a greenish flame and fumes of M. A.

The retort containing chlorine and the rest of the liquid exposed to sun light—colour slowly went—much more slowly than with chloric ether—when retort opened over chlorine slight expansion and little M. A. Gas came out—retort full of M. A. Gas—admitted a little water—agitated it—then admitted more chlorine and again exposed to light—colour disappeared—gave another atmosphere

MOST VOL.
VAPOUR—WITH
CHLORINE.
DETONATED.

of chlorine and exposed to sun light—colour remained and apparently action finished, but no crystals formed as of chloride of carbon, only a tenaceous oily looking fluid.

Of this most vol. oil vapour 1 vol. mixed with 7 vols. of oxygen. 8.8 of this mixture detonated in an Eudiometer tube diminished by spark to 5.7 and then by potash to 1.4 which were oxygen. Hence 7.4 vols. consumed.



Mixture 7.4

Vapour 1.1

Oxygen 6.3

Carb. acid 4.3

Oxygen in C. A. . . 4.3

„ to hydrogen 2.0

diminution by spark 3.1

4 carbons 24

4 hydrogen 4

1 vapour 28

S. G.
28

Submitted some of the vapour to 0° at common pressure—did not condense.

Compressed a portion in a tube by a syringe and cooled it—it then condensed.

Passed Gas from Gordon's Globe through a tube at 0°—a little condensation of solid substance—but very small and might be aqueous.

OIL GAS LIQUID—
DISTILLED.

Distilled the large portion of the liquid from works and received the products in 4 portions—the first came over at temperatures below 170°—the second between that and 190°—the third up to 200°; the fourth was what remained in the retort not distilled.

1825. JUNE 2.

CHLORINE AND OIL
GAS PRODUCTS.

Compound of Vol. Vapour and chlorine—liquid—no crystals—clear and limpid when warm—volatile by heat—decomposed below red heat—apparently much carbon deposited—M. A. Gas came off—and by odour think chloride of carbon formed.

Crystalline compound by Alcohol from Bicarburet of hydrogen and chlorine—in tube fuzes—sublimes unchanged—by high continued heat decomposed—action on glass—carbon deposited—M. A. Gas came off—a fluid formed insoluble apparently in alcohol.

OLEF. GAS
AND OIL.

Olefiant gas with olive oil—6 vols. gas, 1 oil—by agitation for

15' nearly 1 vol. of the gas absorbed by the oil—in two hours about 1.3 vols. gone—in 5 hours continued the same. OLEFT. GAS
AND OIL.

Oleft. gas with oil of turpentine—6 vols. gas, 1 oil of turpentine—by agitation in 15' nearly 1.5 vols. absorbed—in 2 hours no farther diminution—nor in 5 hours.

Air with oil of turpentine in a tube agitated—2 hours, change of volume doubtful, if any thing diminution—in 5 hours still apparently very small diminution.

Coal tar distilled—temp. rose much above 200° before any thing but water came over. Of course no bi carburetted hydrogen. COAL TAR
DISTILLED. It could not be expected from the appearance of the flame of coal gas—for if gas saturated with it, would have much brighter flame than it has.

Rectified each of large portions obtained yesterday. Appearances just as before obtained.

- I. All before 170°
- II. up to. . 180°
- III. up to. . 190°
- IV. up to. . 200°
- V. above . 200°

JUNE 3.

Made some more bi carburet hydrogen—had to rectify again several times before sufficiently concentrated to yield the substance. In pressing it, left it for 10 minutes under pressure in Bramah and afterwards in consequence of presence of a little water from piece of ice rectified it from off caustic lime—obtained it in this way better than before and less fusible. BI CARB.
HYDROGEN.

JUNE 4TH, 1825.

Bi carburet hydrogen.

Fuzing point 42° F., boils at 186°.

With N. A. again very strong odour of Prussic acid or of almonds. BI CARB.
HYDROGEN. ITS
S. G. AND VAPOUR.

For S. G. of its vapour and in liquid form.

Tube and cork	13.86
Do. and substance	15.56
Substance	1.7

BI CARB. HYDRO-
GEN. ITS S. G. AND
VAPOUR.

This in curved tube formed vapour which at 212° equalled 22 divisions or correctly 2.44 c: i: the pressure of the mercury being equalized but under pressure of boiling water $8\frac{3}{4}$ inches and Bar. at 29.98. An equal bulk of water to the substance weighed 2 gr. at 60° .

$$\frac{1.7}{2} = 0.85 \text{ S. G. of the fluid at } 60^{\circ}.$$

2.44 c: i: corrected for $8\frac{3}{4}$ inches boiling water = 2.49 c: i:

2.49 c: i: at 212° = 1.917 c: i: at 60° weighing 1.7 gr.

Hence 100 C. I. at 60° F., Bar. 29.98 = 88.68 grains nearly.

S. G. 41.9 nearly.

A little vapour escaped in this expt.

Again S. G., etc. of Bicarburet hydrogen:

Tube, cork, etc. . . .	16.89
Do. . . and Substance	19.19
Substance	2.3

This gave 3.83 correct c: i: of vapour at 212° , there being a column of mercury 3.1 inches expanding it and a column of boiling water $9\frac{1}{2}$ inches condensing it. Bar. 29.98.

An equal bulk of water weighed 2.7 gr. at 60° .

$$\frac{2.3}{2.7} = 0.8 \text{ S. G. of liquid at } 60^{\circ}.$$

3.83 c: i: corrected for columns of water and mercury = 3.52 c: i:

3.52 c: i: at 212° = 2.71 c: i: at 60° weighing 2.3 gr.

Hence 100 c: i: at 60° F., Bar. 29.98 = 84.87 grains.

S. G. 40 very nearly.

BICARB. HYDRO-
GEN ANALYZED.

Bi carburet hydrogen over oxide of copper.

Substance 0.776 gr.

Tube and charge . . . 345.94

Lost by operation . . . 2.6

Water driven off . . . 0.58

Gas equalled . . . 6.13 c: i: which by potash became 0.34—very slightly inflammable. This leaves 5.79 c: i: which corrected for wrong graduation became 5.6 c: i: of Carbonic acid gas.

5.6 c: i: carbonic acid gas = 2.609 gr. = Carbon— 711704 11.44

0.58 grains water = ... Hydrogen—064444 1

776148

Bi carb. hydrogen over ox. copper.

Substance . . . 0.82 gr.

Tube and charge . 341.86

Lost by operation. 3.00

Water driven off . 0.60

Gas collected . . 7.02 c:i: reduced by potash to 0.29 c:i:

The residue 6.73 corrected for graduation gave 6.51 c:i: Carb. acid.

6.51 c:i: carbonic acid gas = 3.0337 gr. = Carbon— 0.82735 or 12.4

0.6 gr. water = ... Hydrogen—0.06666 1

0.89401

Must be some mistake here: weight of products surpass original weight.

Bi carb. hydrogen over ox. copper.

Substance . . . 0.75 gr.

Tube and charge . . 323.28

loss by operation . . 2.58

Water 0.57

Gas collected . . . 6.08 c:i: reduced by potash to 0.33.

The difference 5.75 c:i: corrected for graduation gave 5.56 c:i: of Carbonic acid gas.

5.56 c:i: carb. acid = 2.591 = Carbon— 0.70662 or 11.16

0.57 gr. water = ... Hydrogen—0.06333 1

JUNE 6TH.

Oxygen 8092 vols. at 62°. Added 0.14 gr. bi carb. hydrogen—vol. of mixture became 8505—hence vapour 413 vols. or $\frac{1}{20.6}$ nearly. 7 vols. of mixture in Eudiometer tube became nearly 6.1 vols. by spark and these by potash diminished to 4.

hence detonated . . 3 vols.	8.5	Oxygen in C. A. to that in Water :: 4 to 1. Oxygen about 7.8 vols., vapour 1 vol.
Carb. acid . . 2.1	6	
Diminution . . 0.9	2.5	
Vapour . . . 0.34	1	
Oxygen. . . 2.65	7.5	
Do. to C. A. . 2.10	6	
Do. to hydro. . .55	1.5	

BICARB. HYDRO-
GEN ANALYZED.

FLUID FROM
BICARB. HYDRO-
GEN: S. G. OF
VAPOUR.

Fluid expressed and otherwise obtained as residum from bi carb. of hydrogen—redistilled. It boils constantly at 186° , no separation into more or less volatile substances.

1.72 gr. converted into vapour gave 2.79 c: i: at 212° , this quantity being compressed by a column of water at 212° of $9\frac{1}{4}$ inches in height and expanded by a column of mercury (212°) at $4\frac{7}{8}$ inches. Bar. 30.06.

2.79 c: i: corrected for pressures of water and mercury
= 2.4 c: i: nearly.

2.4 c: i: at 212° = 1.849 c: i: at 60° = 1.72 grains or
100 c: i: weigh 93 gr. at temp. 60° , Bar. 30.06—or S. G. 44.

The 1.72 grains=in vol. 2 gr. water, hence S. G. of liquid 0.86.

1825. JULY 4TH.

S. G. OF OIL GAS
LIQUID.

Specific Gravity of original fluid.

Water	390.5	} S. G. of fluid 0.821.
Fluid	320.9	

COAL GAS WITH S. A.

Coal gas obtained from Fisher's and preserved for a night over water—then treated in a tube with Sul. Acid. Coal gas not particularly good.

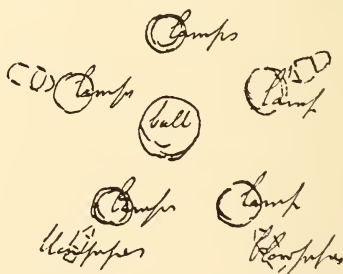
5486 vols. of gas with 276 vols. of oil of vitriol became 5333 in 15 minutes, 5292 in 30 minutes and in 2 hours had not altered further.

Again 2736 vols. of gas with 278 vols. of oil vitriol became 2679 vols. in 15 minutes, 2660 vols. in 30 minutes and in 2 hours more had hardly changed.

Again 1906 vols. of gas with 131 vols. of Sul. Acid became 1860 in 15 minutes and 1842 in 30 minutes—2 hours made no further alteration.

LIGHT OF IGNITED
LIME.

With Mr. Drummond, Furnival's Inn. He is experimenting on the light produced by the strong ignition of various bodies as fitted to illuminate a mirror when placed in its focus for the purpose of surveying. This Evening balls about 3, 4 or 5 tenths of an inch in diameter of lime, Magnesia and oxide of zinc were used; these were supported by a small stem of the substance on a prop placed in the middle of 5 spirit lamp burners, to each of which was adapted a blow pipe jet communicating with one



common flexible tube. The lamps were fed by a reservoir of spirit connected by a flexible tube with them, and being mounted on a stand could be raised or lowered at pleasure so as to supply more or less spirit. The air tube or blow pipe tube could be connected with an air holder of oxygen so as to raise the ball to a very high temperature, it being previously placed in the focus of the mirror.

LIGHT OF IGNITED
LIME.

Another mirror was furnished with an argand oil lamp, and standing by the side of the first offered a wide object for comparison when both were looked at from a distance of about 10 yards.

A ball of lime being heated the light was very white and brilliant, reducing the lamp and its mirror to the appearance of a red coal—the mirror though imperfect in form was well illuminated.

A ball of Magnesia heated did not equal the light of the lime; it was more dim and of a reddish colour, but the colour faint.

A ball of oxide of zinc heated produced powerful light far surpassing the lamp, but not so good as magnesia and nothing like lime. It was of a decided yellow tint, very peculiar and distinct from lime or magnesia.

A ball of lime again—beautiful and brilliant like a voltaic discharge, far surpassing the rest.

The lime became highly caustic but did not change in form or appearance. The magnesia contracted, cracked and became hard and dense—not fused. The oxide of zinc was in part reduced and a blue flame could be seen now and then when oxygen was not full on. It also became discoloured and blackened from deposition of charcoal of alcohol; so also did the lime sometimes—but when plenty of oxygen on none of these effects, and then oxide of zinc seemed fixed and unchanged by the high temperature produced.

John and George Barnard being in a hay field where many large cocks of hay were had occasion to notice the effect and progress of a powerful whirlwind; it took up the whole of a hay cock, raising it in the air, whirling it round and expanding it over a space 6 or 7 times its original diameter and then letting it sink a little in advance on the neighbouring ground or trees. It then took another, and so on, lifting several of them in succession and covering the trees, etc. near them with hay.

WHIRLWIND.

WHIRLWIND. John and George ran to get into its course, and when it came to them they found their clothes whirled and flapped about, a strong wind moving; it could not however lift a heavy body; it after that went to other hay cocks, and they lost sight of it, probably from its going to a field where there was nothing loose to mark its progress.

It is evident that the progressive motion of this whirlwind (and it is the same with most of them) was not due to the advancement by a general wind of that portion of air which was first put into rotation but that of the general mass of air; nearly quiescent, contiguous portions assumed the rotating motion in succession, so that when the air over a haycock had rotated and taken up the light matters beneath, its motion gradually ceased whilst the neighbouring parts revolved and then the first hay raised fell again.

1825. JULY 8TH.

MUR. MAGNESIA. Sol. of Mag. in mur. acid made by boiling—filtered, set aside in a bottle—after some time clusters of small acicular crystals formed, radiating from common centres like tartrate of lime. These not soluble in water—but by plentiful washing gradually resolved into a solution of common mur. magnesia and the earth magnesia—they contain no lime or sul. acid. They are apparently a sub mur. magnesia which is crystallizable, insoluble, etc. and resolved by water into Mur. Magnesia and magnesia.

S. A. ON OIL GAS PRODUCTS, ETC. *Preceding notes respecting the action of Sul. acid on oil gas products, etc.*¹

Most volatile product with Sul. Acid, pp. 144, 145, 147, 152, 189
[200, 201, 204, 224].

Medium volatile Do. pp. 160, 162, 166, 175
[208, 210, 212, 216].

Most fixed products Do. pp. 145, 147 [200, 201].

Bi carb. hydrogen Do. pp. 174 [216].

Naptha, Essential oil, etc. Do. p. 176 [217].

Olefiant gas Do. pp. 148, 149, 151 [202, 203,
204].

¹ The references are to pages of the MS. The corresponding references to pages in this volume are given in square brackets.

Bottles of May 17th examined.

No. 1. On opening it no expansion—smell pungent and fragrant like bi carb. hydrogen somewhat.

Soda tube: colourless—crystals in the solution—bulk diminished perhaps one half—highly alkaline and dense—no carb. acid in it—no precipitate by tests as of sulphuric acid unless previously Nitric acid added. The crystals pressed on paper and examined were found to be *sulphate of soda*—hence this the volatile acid before noticed, its smell rendered peculiar by mixture with odour of carburetted hydrogen, etc.

Condensed fluid tube—empty except a black film which was dry and hard and most abundant at bottom—it burnt with flame leaving a difficultly combustible charcoal.

The bottle contained three substances, the *lightest* a thick tenacious black substance—acid—very combustible—much smoke very slightly acid to taste. Shaken with cold water mixture readily made which on standing gave a solution of acid and the oil floated—the *next substance* was the S. A.; it was much thinner—of a deep brown colour—clear and transparent—when diluted with water slight precipitation took place. *At the bottom* was a black thick tarry looking fluid which was miscible in hot water or by shaking in cold water, and gave a solution of acid and a portion of combustible, thin but dark coloured liquor floated.

The diluted acid from this bottle was saturated with potash—heated—filtered—and evaporated to dryness.

1825. SEPT. 14TH.

The salt obtained digested in Alcohol—the solution evaporated left a very little saline, adhesive, slightly deliquescent matter—neutral—readily soluble in water—more than sul. potash—precipitated by alcohol—fuzing by heat—then burning with flame and leaving a black soluble mixture as of ulmin in potash—when further heated alkaline—but sulphuret potassa formed. Its solution precipitated slightly by sul. baryta.

A solution of *the salt* precipitated by great excess of mur. baryta—the clear solution evaporated to dryness and then a portion heated in a tube became black and evolved an empyreumatic odour—hence a soluble salt of the peculiar kind either barytic or

SUL. ACID AND OIL
GAS PRODUCTS.

not precipitated by mur. baryta. A larger portion heated in platina capsule also blackened—but on adding water the whole soluble except a little charcoal and the solution not alkaline—hence no sulphate of baryta formed, consequently no vegeto-sulphate present.

The precipitated barytic salt washed and dried—this when heated in tube blackened a little and smell of empyreumatic matter—a portion heated in air became white or gray—the residue in M. Acid gave a solution which could hardly be said to be affected by sul. soda, hence no baryta set free from combination. The combination of baryta or its salts with the hydro-carbon seems very doubtful.

Some of the precipitated salt of baryta when washed and pressed was very adhesive before being dried, and when put into water adhered for a long time to the stirrer as if somewhat greasy, refusing for a while to mix with the water—at last mixed and then M. A. added did not dissolve any baryta or salt of baryta but on evaporation left a brown empyreumatic matter.

There is perhaps a soluble substance formed in the first instance which afterwards accompanies the acids, salts, etc.

Some of *the salt* dry—heated in a closed tube—became black—evolved empyreumatic odour, also water and fumes, and the residuum in water was alkaline though apparently no sulphuret had been formed, for M. A. produced no smell of Sul. hydrogen.

The salt is apparently more soluble in water than sulphate of potash—when solutions of the two are evaporated they differ very decidedly in aspect and manner of crystallizing; the new salt assumes a silky or pearly appearance like acetate of potash or acetate of mercury, especially if the salt be dried. Its taste was also more bitter than that of pure sulphate of potash.

1825. SEPT. 17TH.

SUL. ACID ON OIL
GAS PRODUCTS—
PEARLY SALTS.

A hot saturated solution of *the salt* set aside to crystallize gave this morning acicular crystals in spherical groups occupying full half the bulk of the original solution. The crystals were flat, thin and somewhat flexible—like thin plates of white mica—resembling boracic acid in appearance. The groups at the surface had a white silvery silky appearance and this was heightened when the crystals

were drained, exposed to air and broken down—they then contracted very much, the bulky groups occupying but a small space when pressed.

SUL. ACID ON OIL
GAS PRODUCTS—
PEARLY SALTS.

These crystals when heated in a tube gave off but little water—blackened—did not fuze—did not flame—and only little combustible matter in them—the ashes, etc. put into water gave feeble alkaline solution and little charcoal—the solution yielded common crystals of *sulphate of potash*.

Sol. of sul. pot. crystallising at same time had usual appearance—quite unlike *the salt* unburnt.

Ether does not dissolve any part of *the salt*.

It would appear that much common sul. potash must be contained in *the salt* and but little of any peculiar salt or compound; yet it is curious that the sulphate of potash cannot be separated by crystallization, but has peculiar crystalline characters impressed upon it.

Bottle No. II of May 17th examined.

Volatile liquid tube: contains a black film—pulverulent when scraped and not like asphaltum—it burnt with flame leaving pure charcoal—the tube was dry.

SUL. ACID AND OIL
GAS PRODUCTS.

The alkali tube: was very similar to the former, containing a few crystals of sulphate of soda but in small quantity. Should like however to try a similar experiment with less alkali and diluted.

The bottle contained *three* immiscible fluids. *The lowest* the acid of a deep brown colour—above that a little of a *deep black substance* like fluid tar—and over that again a very dark brown liquid—volatile, inflammable and slightly acid—it is that substance which most resembles the original fluid. There was not any or at least only very thin films of the thick black almost solid substance formed in Bottle No. I. There was a good deal of the *most volatile portion*, perhaps one third of the original volume of fluid or even more.

The tarry substance added to water sank in it but by agitation much acid washed out, the bulk diminished and nothing was left but a little lighter oil and a few black flocculi resembling charcoal.

The acid diluted became very slightly turbid—filtered—neutralized with potash gave a salt—which in some thing[s] as lustre,

SUL. ACID AND OIL
GAS PRODUCTS.

colour, etc., resembled that of Bottle I but did not crystallize so readily in acicular crystals; the tufts were very small and more general yet not like sulphate of potash. The first crop of crystals dried, etc.—burnt with odour—blackened a little more than former and became also more alkaline. Obtained a second crop of crystals in appearance like the first—proceeded to try the small quantity of mother liquor left from them—this evaporated gave a salt blackening more than former by heat—becoming also more alkaline. Mixed with Sul. acid it did not evolve Acetic acid and blackened much in the acid by heat. Very small piece of Acetate potash in Sul. acid evolved odour of A. A. and did not blacken so much by heat. The whole salt washed with alcohol, filtered, solution evaporated—a substance obtained, sol. in water, in alcohol—slightly acid from excess of acid at first—when heated fuzing—blackening—burning with flame and leaving black residuum strongly alkaline—hence a combustible acid or salt—put into Sul. Acid did not evolve acetic acid odour.

A portion of the whole salt washed several times in alcohol—still when heated discoloured a little and became slightly alkaline. The salt washed in alcohol, filtered, pressed—then dissolved in water and crystallised. The crystals had all the pearly aspect of the salt before observed and did not resemble sulphate of potash. Hence salt retains something powerfully which causes it to assume this aspect.

The most volatile portion of this Bottle No. II or that which floated added to fresh sul. acid and shaken—miscible—after a few minutes separated leaving a black acid below and floating above was a small portion of fluid resembling that put on—more acid added and the whole shaken up—then after several days no separation—acid remained black and a smell of sulphurous acid was slowly evolved. On dilution acid became slightly turbid—on standing very little oil separated indeed—the acid neutralized by carb. potash—solution heated—filtered—and crystallised—no separation of the oil. The salt obtained was pearly, soft and exactly like the former.

A portion of this salt in cold saturated solution set aside to crystallize slowly and spontaneously.

Another portion dissolved in water and boiled in a florence

flask for many hours in order to dissipate anything volatile; it acquired a slightly brown tint but on crystallization yielded the pearly salt as before.

SUL. ACID AND OIL
GAS PRODUCTS.

1825. SEPT. 21.

Bottle No. III of May 17 examined—Sul. Acid and Hay.

SUL. ACID ON HAY.

On opening the bottle a strong smell of acetic acid—added water and agitated—black part of the hay insoluble—filtered the acid—neutralised by potash—heated—filtered—and crystallised—the crystals obtained were gritty and like sulphate of potash but when heated became discoloured and very slightly alkaline. Alcohol added to the mother liquor precipitated much salt—the alcohol solution filtered off and evaporated became olive greenish and when dry gave an aqueous salt burning and leaving an alkaline ash—it was deliquescent—in Sul. Acid it evolved acetic acid. It was an acetate of potash mixed with some muriate of soda and some brown destructible matter burning and smelling as if of an animal nature.

The salt precipitated by the alcohol when dissolved in water and recrystallized gave merely sulphate of potash.

1825. SEPT. 23RD.

Solution of sulphate of potash agitated well with portion of volatile liquid (boiling at 180°) for some time and then filtered and crystallised. Crystals merely common sulphate of potash—no combination.

SUL. POT. WITH OIL
GAS PRODUCTS.

Results of S. A. and most volatile portion left from May 25th.

SUL. ACID ON OIL
GAS PRODUCTS.

The acid saturated with potash—filtered—crystallised—the first crop of crystals were merely sulphate of potash—crystallised the mother liquor—second crop of crystals still only sulphate of potash—did blacken a very little upon being heated as if something destructible by heat were present—evaporated again—again sul. potash—rest evaporated to dryness—a little burnt with flame but did not become acid or alkaline. Alcohol dissolved a small portion of matter from the rest, burning brightly and apparently of an oily or highly inflammable nature.

VARIOUS OIL GAS
PRODUCTS
AND TIME.

Tubes of various products of condensed liquor which had been set aside closed by corks—the results obtained at 140° , 150° , 176° and 200° had nearly all evaporated and left a thick fluid below, in appearance like cold castor oil. A cold of 0° only rendered it thicker and tenaceous like gum or soft rosin—warmth rendered it fluid—if temperature raised on sand bath sudden action as if explosion, but was dull, and when heated over mercury without air and by lamp it did not happen—was probably only rapid and sudden ebullition—the heat deepened the colour very much—solution of potash acted slightly upon it, deepening in colour, but when filtered acid scarcely separated anything—a large portion was left unacted upon by the alkali.

1825. SEPT. 27TH.

SUL. ACID AND OIL
GAS PRODUCTS.

Strong Sul. acid in a tube, liquor (boiling at 140°) added to it, much heat and ebullition—discolouration—cooled the tube and its contents—added more liquor until it equalled twice or thrice the quantity of Sulphuric acid—has now been left for some days.

To day examined. The whole very dark coloured, almost opaque, but thin films at the surface of glass appeared of a deep inky purple colour. There were two substances in the tube but though they had spontaneously separated they seem miscible with each other. The upper fluid being also the thinner was poured off from the lower and thick portion.

The *light thin fluid*—of a deep inky purple colour in thin films—opaque in any quantity—consisting of thin or coal tar. A film exposed to air changed colour as the acid absorbed water—from inky purple it changed to fine violet—blue (dull indigo tint)—greenish blue—fine dark green—paler green which became more and more pale as it diluted itself. On diluting a portion with water the same tints were produced. On adding about half its volume of water and agitating, a perfect mixture was obtained of a fine deep green colour—on adding more water and either agitating or allowing time for rest a separation took place—a colourless heavy acid sunk—and upon it floated a deep green coloured oil (much thinner than before)—removing the acid by a tube a second portion of water was added and agitated with the oil—on standing it separated but not quite so readily as before—it

was removed, added to the former acid—and filtered—it was colourless and the oil was left of a deep green colour and opalescent.

SUL. ACID AND OIL
GAS PRODUCTS.

The acid was quite colourless—it had a slightly aromatic smell—when evaporated on a sand bath, it when concentrated became dark coloured (inky)—afterwards reaction appeared to take place and it became deep brown, strong aromatic or camphor odour rising at the same time—the substance did not seem volatile here—was then acid—heated still more, charred and became quite black—acid began to rise in vapour, etc.—on cooling water no longer dissolved the whole—charcoal left.

A portion of the same acid put in a flat dish to evaporate over Sul. Acid under air pump receiver—as it became concentrated there was action and the whole took a strong brown colour. On dilution with water the brown went and a pale green colour appeared; a little green solid matter ultimately separated and a clear acid solution remained.

Another portion made into a potash salt gave pearly crystals.

Another portion after long boiling, being saturated with potash and crystallised, gave crystals not so pearly as should be—the pearly character appears to have been injured.

The green oily portion left by the water—was opaque and turbid—colour dark dull apple green—heated in a tube a little water separated and oil above became very dark green and free from turbidness—heated in an open basin it soon cleared—became very dark green—then almost black—but by exposure to air and moisture returned to dark green again—in this state soluble in fixed and volatile oils and also in volatile fluid, forming green solutions. Reheated, again darkened through purple to black and by cooling went back again—aromatic odour—combustible—burning with flame—is apparently very slightly acid but not to taste. Continued and higher heat drives off something volatile—the substance darkens in colour, becoming deep blue and this if cooled is hard and solid—when dissolved in essential oils it resumes its green colour—by further heat, after blackening, charred and was decomposed.

Some of the green oil distilled—water and colourless volatile oil came over—smell aromatic. Part of this product in a tube put into a bottle with sulphuric acid—action gradually took place

SUL. ACID AND OIL
GAS PRODUCTS.

but by no means with a rapidity to that in the original liquor—left to complete. Another part had about 12 vols. of sulphuric acid added to it—slight browning but not much action—only about half the oil dissolved—rest after a time floated.

The residuum in the retort was thick and of a dark green colour like that left when evaporated in a basin.

GREEN SUBSTANCE
FROM SUL. ACID
AND OIL GAS
PRODUCTS.

Alcohol added to some of the green oil produced a precipitate, green at first but becoming brown, and the solution filtered was of a faint yellowish colour whilst the precipitated portion was brown and soft like honey. This residuum dissolved in volatile oils or in the liquor and on adding strong S. A., the solution from brown became green—when residuum heated it boiled up—volatile portion evaporated and a substance was left hard and solid when cold but still retaining solubility and other characters—further heat caused it to burn with much smoke—then nothing left. When it was boiled in water some time, no solution, but the volatile part was dissipated and a portion left like that produced by heat, except that it was not so hard and retained a little water—the substance is heavier than water—solution of potash boiled with it acts on it very slightly, changing its colour but not dissolving anything.

The Alcoholic solution of the green oil was of a yellow colour. Evaporated, it gave aromatic odour and left slight brownish green substance becoming green by water or acid—dissolving in volatile oils or products and giving green or brown solution—sul. acid made it very green—quantity small.

One volume of water added to alcoholic solution became turbid and white, but no precipitation—no separation on standing some hours—4 vols. of water and a little potash added—still no signs of separation.

Dry chloride of lime added to the alcoholic solution—still no separation induced.

Some of this alcoholic solution added to warm saturated solution of sulphate of potash—slight turbidness—filtered and crystallized—crystals common sulphate of potash—no pearlyness.

The thicker portion of the original mixture examined—of a deep chocolate brown colour—like thick tar—heavy—in water changed slowly, the acid by degrees separating from it and the colours

(green, etc.) being produced, but not so finely as in the former instance—strong odour of sulphurous acid.

The acid solution separated and neutralized with potash gave pearly crystals.

A portion of *the Residue from water* boiled with water in a tube had volatile matter separated and a brown substance remained—insoluble in water or alcohol—hard—burning with flame—soluble in volatile liquids or in oils forming a brown solution which by M. A. or especially Sul. acid became green.

The rest of the residue from water well shaken with alcohol and left 12 hours—then an alcoholic solution and an insoluble substance below it.

Alcoholic solution—deep olive brown colour—not turbid—when evaporated left a small portion of dark inkey coloured fluid which on adding alcohol dissolved again forming a green solution—water also made it green but did not dissolve it—volatile oils and the fluids gave greenish brown solution of it—fixed oil did not dissolve it. *Alcoholic solution* (original) with water caused slight turbidness but no distinct separation of fluid even when heated. Its taste was hot—slightly acid—and bitter—is acid to litmus.

Insoluble substance from Alcohol—like soft pitch or thick treacle and similar colour—combustible—soluble in fixed oil, volatile oils giving brown solution—in volatile liquor giving greenish solution becoming fine green by little heat—on evaporation substance left and on re-solution colour not so fine as before—the substance altogether very like residue from distillation of green oil. The two put together, alcohol boiled with them and left for future examination.

GREEN SUBSTANCE
FROM SUL. ACID
AND OIL GAS
PRODUCTS.

1825. SEPT. 28TH.

A little sulphur burnt in a dry bottle to produce sulphurous acid—a few drops of volatile liquid poured in—in 24 hours very considerable brown shade produced—by water the colour becomes olive green. Hence suls. acid *does* act on these fluids and hence the discolouration of the tubes of liquor in bottles with Suls. acid.

SULS. ACID AND
OIL GAS PRODUCTS.

1 Vol. S. A., 3 vols. water mixed—a little fluid (180°) added and left for several days, shaking at intervals—the oil gradually became

DILUTED S. A. AND
OIL GAS PRODUCTS.

DILUTED S. A. AND
OIL GAS PRODUCTS.

brown and brownish green and the acid remained opalescent after long standing—hence had been action which here could not be in consequence of attraction of acid for water. Acid saturated with potash, filtered and salt crystallized gave only common sulphate of potash—probably by longer action would have given pearly crystals. Action continued to Nov. 4th, but still common sul. potash given on saturation, etc.

Solution of pearly sulphate of potash boiled for some time with white cornish clay, then filtered and crystallised—gave pearly crystals apparently unchanged.

1825. SEPT. 29TH.

POTASH AND OIL
GAS PRODUCTS.

Potash dissolved in alcohol—volatile fluid added to it—left all night—next morning the alkali made a sulphate—boiled—filtered and crystallised—but no silky crystals, merely sulphate of potash.

SUL. ACID AND
NAPHTHA.

Sul. Acid and Native Naptha mixed in a glass—some heat evolved—deep brown colour—not complete mixture, part of the Naptha floating—added water, white precipitate—made acid a sulphate of potash—filtered—crystallised, gave merely sulphate of potash—crystals examined by heat, nothing destructible, not a trace.

S. A. AND OIL OF
LAUREL.

Sul. acid and native oil of laurel—mixed—much heat—reddening, becoming deep brown—ultimately complete mixture—acid became thick and viscid—much suls. acid—added water gradually—separation of brown mass—made acid a sulphate—crystallized slowly gave prismatic crystals which under the solution did not appear pearly—a little more concentrated it gave an abundant crop of very pearly crystals—these when drained, pressed and heated charred but remained neutral.

SUL. ACID AND
OIL TURPENTINE.

Sul. Acid and Oil of Turpentine—heat and action—on dilution acid very turbid—neutralised by potash and filtered—still very turbid and filtering slowly—the solution crystallised gave very silky crystals, burning and charring—ashes little alkaline. The residuum from first solution miscible with water. When turbid solutions boiled a matter separated on the surface—resinous—combustible—soluble in alcohol—miscible with water as before. All the products here probably worth careful examination.

Sul. acid and Olive oil—heat produced—deep brown colour—perfect union—added water—gelatinised and became white—odour of sulphurous acid—by agitation frothy and saponaceous—little turbid but no separation of oil from it—heated—then a solution of acid below and a coagulum above—separated the acid, neutralised by potash—solution frothy and saponaceous—crystallised—crystals were not pearly—resembled sul. potash—charred a little by heat—mother liquor evaporated and heated charred much but neutral. The coagulum white—added to more water—quite miscible—on heating, no separation but a kind of emulsion—put into a glass and left—was very frothy—when cold almost mucilaginous.

SUL. ACID AND
OLIVE OIL.

Sul. acid and Napthaline—no heat—no rapid action—solution formed slowly—red colour—on dilution became only slightly turbid—neutralised by potash—still no separation of Napthaline—filtered and evaporated—when hot and just forming film set aside but did not crystallise in some time—evaporated a little more—set aside and after a time full of very minute silky crystals in tufts which gave the whole when stirred not the appearance of salt and liquid but that of a very strong solution of soap—by stirring a while so much more crystallised that the whole became a soft solid and then felt like soft soap—crystals apparently acicular or fibrous—dried a portion—when heated it burnt with flame and left salt—very little alkaline though much charred—put a portion of the dried salt into alcohol. The alcoholic solution evaporated left a crystalline substance burning with much flame and leaving a little alkaline residuum. The substance itself soluble in water.

SUL. ACID AND
NAPHTHALINE.

Redissolved a portion of the salt and set it aside to crystallise slowly; next morning had not crystallised much in dish though there was some minute reddish spherical arrangements, but had passed over the side crystallising thickly there and then running over the shelf and up the neighbouring bottles—the crystalline vegetations were very beautiful, ramose, dendritic, etc.—and highly silky.

Sept. 30. The reddish crystals in the basin when examined were found to resemble roes of a fish or small pisolite—were minutely crystalline on the surface and as if composed of radiating fibres—were hard globules—when heated burnt with little flame—charred

SUL. ACID AND
NAPHTHALINE.

but remained nearly neutral—the white pearly and vegetative crystals were far more combustible—much flame—diminished much in size and weight—became very black—and were alkaline to turmeric. The pisolite crystals dissolved in water and evaporated to a pellicle—then left to crystallize; after a time found a few pearly speculæ at the surface—some fibrous crystals below—crusts and crystals had begun to creep up the side to the top, and these were very thick, and upon stirring the whole assumed the gelatinous or soapy feel spoken of at first. Alcohol added made the whole white and opaque—filtered—a solution was obtained which in properties corresponded with the one to be described onwards—the residue was pressed and disposed of as to be described.

The pearly and vegetative crystals were rubbed in alcohol, the alcohol filtered and the residue washed with a fresh quantity. The residue like that above no longer burnt with flame, but charred only and remained neutral—both residues were redissolved in water—recrystallised and gave crystals of sulphate of potash.

The alcoholic solution evaporated gave at last an aqueous solution which on cooling crystallised—by further evaporation a crystalline pearly substance was left—soluble in water and in alcohol—white—slightly acid (from excess of S. A. probably)—combustible with bright flame leaving a little strongly alkaline ash—heated in a close tube a little water rose—also a crystalline body—some gas—very little discolouration except of ash, which was black and alkaline. The volatile crystalline substance was *not* soluble in water—sol. in alcohol precipitated by water—burnt with flame, fuzing first and in all evident characters resembled naphthaline.

An aqueous solution of the substance by alcohol was not precipitated by nitrate of lead—mur. baryta—sul. copper—nitrate of silver—S. A. did not separate naphthaline from it.

It would seem to be a soluble unprecipitable salt composed of Naphthaline and potash?

1825. SEPT. 29TH.

S. A. AND CAMPHOR.

Sul. Acid and Camphor—dissolved slowly—pinkish solution—water precipitated white camphor—separated—acid neutralised—

crystals not pearly but brittle—were common sulphate potash—
mother liquor evaporated to dryness and heated charred very
little indeed. S. A. AND CAMPHOR.

1825. OCTR. 1.

Napthaline in S. A., the former in excess—heated—deep red
solution—on cooling, much of napthaline recrystallised—gave
higher heat—deep red solution—colour changed gradually and at
last became olive green, dark—very little vapour of napthaline
evidently held down—when cold was clear, did not crystallize
but more like honey—smell decidedly sulphureous—diluted, no
precipitation—hence napthaline changed—the solution rubbed
with marble till neutral—filtered—solution evaporated—digested
in alcohol and a salt obtained which was combustible but not
with flame, burning like charcoal and leaving a *neutral* ash. SUL. ACID AND
NAPHTHALINE.

Some Napthaline in fragments put into sul. acid in stoppered
bottle—well shaken and left till Monday.

OCTR. 3RD.

Bottle now contained a thickish fluid, deep red and a crystalline
solid. The fluid part dissolving entirely in water, the solid part
leaving a few particles of white napthaline but principally dis-
solving. Water was added to it in the bottle and both shaken
together; in this way a solution obtained which when filtered
was clear and transparent and of slight brown tint. I observed
that on adding a little water and allowing to cool a deposit took
place (crystalline) which dissolved on adding more water—
probably a definite compound of acid and napthaline.

This diluted acid had a bitter taste.

A portion of diluted acid saturated with potash—alcohol added
to precipitate sulphate of potash and the alcoholic solution
filtered and evaporated—a crystalline salt obtained—neutral—
soluble in water and alcohol—tastes bitter—giving but very slight
trace of sul. acid to mur. baryta—burning with jets of flame—
fuzing and blackening at same time and leaving a strongly
alkaline ash—this might be from formation of sulphuret. Another
portion of this potash salt redissolved in alcohol to separate
sulphate perfectly—then solution evaporated to dryness—a portion

SUL. ACID AND
NAPHTHALINE.

dissolved and tested by M. B. gave *no* sul. baryta. The rest burnt on clean platinum foil left very alkaline ash which in water did not smell of sul. hydrogen and by digestion with N. Acid gave a solution which examined by M. Baryta gave *no* appearance of Sul. acid or sul. baryta.

Another portion of the *diluted acid* rubbed in a mortar with artificial carbonate of baryta until neutral—then filtered—a solution obtained—neutral—precipitated by sul. soda—hence containing baryta and no sul. acid—evaporated gave a white salt which burnt with bright flame—sol. in water—alcohol—crystalline—its ash black and carbonaceous—the ash with M. Acid and then sul. soda *did not* precipitate. It more resembled in appearance a sulphate of baryta than a carbonate as expected—try again.

The solution of the Barytic compound with S. A.:—a precipitate of sul. baryta but there was a little excess of free sulphuric acid—hence its acid properties not certain when pure—solution clear—on evaporation blackened a little—on cooling partially crystalline—by higher heat sublimation, inflammation, etc. etc.

1825. OCT. 4.

A larger portion of the *diluted acid* rubbed with native carbonate of baryta till neutral—left to settle—clear solution filtered—neutral to litmus and turmeric—not precipitated by mur. baryta—precipitated abundantly by sul. soda—hence decidedly contains soluble salt of baryta—a portion evaporated in drops on a glass plate—left pearly white opaque rings, slightly crystalline—perfectly re-soluble in water or in alcohol—nitric acid added to a dry drop, then water; complete solution—no turbidness from formation of sulphate. The whole of the solution evaporated to dryness left considerable quantity of a perfectly white salt—soluble in water and alcohol but not in ether—ether separated nothing from it—the dry salt heated burns with flame, puffing a little at the same time like coal, leaving a mixture of charcoal and *sulphate* of baryta—no carbonate.

A portion of the salt in water boiled with N. Acid—no precipitation of sulphate—added Mur. acid—boiled in the N. M. Acid still no precipitate—a little sul. soda caused much precipitation.

Napthaline boiled in solution of potash—left all night—saturated by sul. acid—filtered, concentrated—treated with alcohol and alcoholic solution evaporated—left very little residuum—that slightly carbonaceous and the ash neutral sulphate of potash.

POTASH AND
NAPHTHALINE.

Of the *diluted acid* half rubbed with marble till neutral—water added, solution or mixture filtered—evaporated—when almost dry added alcohol to separate all sulphate of lime—evaporated the clear solution and obtained the *lime salt*.

SUL. ACID AND
NAPHTHALINE.

The rest of the acid neutralized by carb. potash—the solution filtered—evaporated to dryness and treated with alcohol—the alcoholic solution filtered and evaporated gave a *potash salt*.

OCT. 8TH, 1825.

About equal vols. of Napthaline and Sul. acid heated and agitated together in a glass tube—became of a fine red colour—when cold there was on the top a solid portion and beneath a liquid portion. These examined apart.

Solid portion: reddish or white in parts—highly crystalline—in water gave an acid and bitter solution and left Napthaline—the solution saturated with potash and treated with Alcohol gave much peculiar salt of potash and but little common sulphate. The *fluid or acid portion* was red—more fluid I think than S. A. generally—put into water no precipitation—treated with potash and alcohol gave very little peculiar salt and much sul. potash.

The Napthaline from above portion dried—heated with a little more S. A. as before—and when cold the solid part triturated in water. The acid solution was bitter, etc. as before—rubbed in a mortar with native carbonate of baryta—soon neutralised—not much carbonate used—filtered and evaporated—much peculiar barytic salt produced. The insoluble residue acted on by Mur. Acid to remove carbonate of baryta left but little common sulphate. Hence this a good process; the peculiar compound of Acid and Napthaline seems readily soluble in unchanged Napthaline—salts probably also soluble, etc.

OCT. 10, 1825.

On Saturday (8th) had heated and shaken together about 4 parts napthaline and 2 parts by vol. of Sul. Acid—when hot set

SUL. ACID AND
NAPHTHALINE.

aside wrapped up, that it might separate and cool slowly. This morning the solid cylinder was taken out and the small quantity of acid thrown away.

The solid cylinder was red inside and soapy or soft to the touch, but where exposed to air or moisture it rapidly attracted moisture, became white and damp and harsh to the touch from deposition of Napthaline. It is deliquescent—bitter to taste—much heavier than water, probably twice as heavy. A portion of it put into a tube and refused melted into a clear deep red liquor and on cooling became a crystalline solid, but there was no further change at that temperature. The whole put into a tube with about one fifth its bulk of water—heated, melted and agitated—two fluids appeared—the portion at top was small in quantity—colourless—became a crystalline solid on cooling and was pure naphthaline.

The fluid below was of an uniform deep red colour—transparent—on cooling crystallization took place throughout the mass, commencing in tufts which increased over the whole—it then appeared of a yellow brown or dirty fawn colour though the fluid state red. A Little more water then added—heat applied—still soluble but now of a brown colour—on cooling partly crystalline as if not enough water to dissolve whole—tested by Mur. Baryta it *contains* sul. acid—hence not pure compound and Napthaline only. More water added, apparent precipitation of something, but on cooling the matter remained generally in solution—filtered—obtained a clear brown solution and a little solid matter in flaky crystals which proved to be Napthaline. On the whole not more I think than a fourth of the Napthaline originally used re-separated unaltered.

The greater part of this acid rubbed up with native carbonate of baryta until neutral then filtered, repeatedly washing the insoluble portion to separate all the peculiar salt—(the latter washing[s] were reserved appart to ascertain if they differed at all from the earlier).

1825. OCTR. 11.

BAR: SALTS FROM
S. A. AND
NAPHTHALINE.

A portion of yesterday's barytic salt set aside in solution when warm to crystallise. Minute tufts gradually appeared on the glass under the solution which were composed of small prismatic

crystals—being left all night, collected, pressed and dried next morning—were white and glistening—by heat on foil flamed but little, burning more like tinder—left merely sul. baryta—in tube by heat gave off very little naphthaline—left very carbonaceous sulphate—evolved fumes or smoke empyreumatic like those of decomposing vegetable matter. These crystals decidedly different to the others—contain much less combustible matter—boiled in water dissolved but not in great quantity—very little dissolved when cold—hot solution deposited crystals abundantly. Alcohol dissolves it—salt is almost tasteless whilst other salt is of decidedly bitter taste.

BAR: SALTS FROM
S. A. AND
NAPHTHALINE.

Another portion of the first barytic salt in solution was carefully precipitated by Sulphuric acid until, being tested by sul. soda and mur. baryta, it appeared nearly free from sul. acid or baryta—there was the merest trace of baryta present. This therefore the *pure new acid*. It was acid to litmus paper and when concentrated had a bitter acid taste. The solution was evaporated on a sand bath to a certain extent and then a portion placed over sulphuric acid under an exhausted receiver. Next morning—examined—was a soft solid, white—deliquescent in the air—taste bitter and slightly acid—after taste metallic like copper or silver—in a tube slight heat (below 212°) melted it without change—on cooling crystallises from centres—at last quite solid—more highly heated, water went off—acid became red slightly but still no sul. acid evolved or any charring. On cooling, when tested by Mur. Baryta, very minute trace of Sul. acid. Further heat, little Naphthaline rose—more discoloured—red became deep brown—then sudden action—spreading—acid becoming black and opaque—but still no suls. acid. Further heat—then naphthaline, suls. acid and charcoal—residuum still adhesive, solid when cold—with water gave charcoal and a black solution and this with carb. baryta gave sul. baryta and a little soluble salt of baryta still.

Another portion of the *pure acid* was evaporated by heat without any great care—when very concentrated it began to assume a brown colour—and when cold became thick and solid almost like cheese—but very deliquescent—it[s] crystalline nature not observed here—when more highly heated it melted—then began to fume—charred—but did not flame—left black charcoal.

PURE NAPHTHALINE
ACID.

PURE NAPHTHALINE
ACID.

Solid acid dissolved in a little water—sol. Mur. baryta strong occasioned a precipitate, but water dissolved it, hence this acid decomposes the muriate forming peculiar salt.

Solid acid and Naphthaline fused together in a tube would *not* mix, the acid containing too much water.

Solid acid left for a longer period under the receiver became at last perfectly dry to appearance—*hard and brittle*—remained white, there being no reaction of the S. A. at common temperatures.

FLAMING BAR.
SALT.

Barytic salt of Octr. 8th very white and pure in appearance—heated in the air it burnt with much flame and left a carbonaceous sulphate of baryta—this by heat formed a little sulphuret of barium but certainly no carbonate—hence S. A. an equivalent to the baryta or base. The salt heated in a tube—a little water rose—then much Naphthaline with some tarry naphthaline—vapour very acid to nose but not fuming or like thick smoke—quite invisible and apparently pure acetic acid and a charry sulphate left. The Barytic salt not soluble in Naphthaline or in oil of turpentine—unchanged by them—no naphthaline separated?

OCTR. 12.

TINDERY BAR.
SALT.

The latter washings of Octr. 10th (mentioned in parenthesis)—evaporated—solution of a barytic salt obtained—salt appears more crystalline than former—hot saturated solution forms pelicle, crystalline—not so pearly as former salt, more like that of common salt—a drop of hot solution on glass plate deposited crystals looking hard and gritty like drop of alum solution—evaporated to dryness gave a salt which burnt just like crystals (of yesterday)—tindery—is probably the same salt and was mixed with them; may be distinguished as *second barytic salt* or tindery barytic salt.

BARYTIC SALTS—
DIFFERENCES.

The solution from which crystals of second salt of yesterday were deposited, when evaporated gave a pearly salt burning with bright flame more like *first barytic salt*. The salts probably only differ by the quantity of hydrocarbon since both leave neutral sulphate of baryta after combustion.

First barytic salt will bear a temperature of at least 460° before it browns—at 480° very slightly brown and still retains naphthaline

—at about 520° naphthaline begins to separate—at 540° browning and vapour of Naphthaline rising. BARYTIC SALTS—DIFFERENCES.

Barytic salts, first No. 1, second No. 2—boiling saturated solutions made of both—on cooling, No. 1 nearly solid; No. 2 by no means so: shook them, then crystals in No. 1 filled about $\frac{2}{3}$ of solution—those of No. 2 about $\frac{1}{4}$ of solution. Took equal portions of cold saturated solutions and added equal quantities of sul. soda (in excess). No. 1 denser precipitate than No. 2—diluted No. 1 with water till shade apparently like that of No. 2; it required 1 vol. No. 1 and four vols. water to reduce it to No. 2. Hence No. 1 much more soluble both in hot and cold water than No. 2.

1825. OCTR. 13.

Glacial Phosphoric acid and Napthaline heated in tube. Napthaline fused—acid solid—little reddening—agitated, etc., then Napthaline poured off—in mortar with water—slightly acid—added carbonate of baryta—when neutral filtered—solution gave no trace of baryta to sul. soda—evaporated, left mere film, very slight charring by heat. MUR. AND PHOSPHORIC ACIDS WITH NAPHTHALINE.

A drop of water added to acid so as to make strong solution—then heated and agitated with naphthaline—two fluids—at top Napthaline, crystalline when cold—below dark opaque acid—acid cold thick, not solid—rubbed altogether in mortar with carbonate of baryta—could not render it neutral to litmus though carbonate in excess—filtered—solution a little acid to litmus—not to taste—tested by sul. soda, very little baryta—evaporated, left mere film—charring very slightly by high heat.

Muriatic acid gas passed through boiling and heated naphthaline—after some time—suspended the action—and allowed the naphthaline to cool—no appearance of action—when examined was found unchanged. *No action.*

Napthaline containing a little fluid (naptha) between crystals so that when pressed in bibulous paper it moistened it—reddish but finely crystalline—700 gr. of this Napthaline in a florence flask with 520 gr. oil of vitriol—melted together and well shaken over a lamp for 30 or 40 minutes—red—left to separate and cool slowly, covered up. When cold flask broken—contained red cake SUL. ACID AND NAPHTHALINE.

SUL. ACID AND
NAPHTHALINE.

at top, crystalline, etc., as before—below that some fluid acid containing granular concretions floating at top—these soluble in water. The cake scraped to remove adhering acid—wiped—then cut up and put into another flask and then 300 grains more of naphthaline added which with the cake made 1536 grains *. These fused and well shaken seemed to mix, but opaque—were after a time poured into tubes, and the matter was then observed quickly to divide into two parts nearly equal in bulk, but the heaviest most. The lower deep red—opaque in the tube (half inch)—the upper also deep red but could see through it by candle—clear. On cooling both solidified—crystallizing, but the upper first—the upper much lighter than the lower—left all night.

1825. OCTR. 14TH.

This morning worked with the substances in tubes of yesterday. Looked uniform—no difference between the upper and lower substances except that the lower was of the deepest red colour and the crystalline grain upon its surface rather the smallest. There were two tubes. One opened—the upper portion put into a dry bottle—and the lower portion into another dry bottle—the part about the junction put into another tube. The *upper portion* when cut by a knife felt gritty and harder than *lower portion*, the latter having a soft and tallowy feel when cut. The *lower* was soft and tallowy to the fingers too—the upper harsher and harder, more like fused naphthaline. The second tube opened and the upper and lower portions separated—the lower portion was still softer and even moist on exterior as if moistened with somewhat—there was also a vacant space between it and bottom of tube as if some other fluid (acid) had lain there and then been absorbed by capillary attraction. The junction put with the former and these now fused—observed that there were the two portions as before and also at bottom a small quantity of a light brown or colourless fluid, probably *sul. acid*. On cooling the upper portion crystallised first—then the one below it—the bottom portion did not crystallise at all. It was probably the absorption of this part which made

* I had some slight suspicion afterwards that 500 grains had been added instead of 300—but think from recollection of bulk that could not be.

the *second lower portion* softer than the *first*. I find the bottom of the *first* lower portion is in the same state. The colourless fluid examined was Sul. acid with some organic or hydro carbonic matter.

SUL. ACID AND
NAPHTHALINE.

Now purified the two portions by fuzing each separately in tubes and retaining them in fusion for some time. On opening tubes of lighter substance when cold the bottom was rejected as impure and added to mixed portion to be repurified. On opening tubes of heavier substance the top was in like manner rejected and added to portions to be purified. The different parts of heavy matter kept separate, some seeming to retain more acid than others. This done several times. The residuary pieces all fused together when the two matters separated and were purified by successive fusions as before.

OCTR. 15.

Two substances examined—*Lighter substance* crystalline—dull red colour—easily broken in mortar—adhesive like naphthaline—powder nearly white—on foil burns like naphthaline, leaving a little charcoal—fuses first—in tube, heated—colourless and tasteless naphthaline sublimes—a black substance is left, acid, soluble in water—soluble in Naphthaline—by further heat giving a little Naphthaline, charcoal and sulphurous acid. *Lighter substance* is highly sapid in the mouth, acid, bitter and astringent. Its quantity altogether 600 grs. nearly—it becomes slightly turbid by heat between fuzing and boiling but clears as it cools towards fuzing point. Rubbed in water and filtered it left a residuum which proved to be pure Naphthaline—filtered solution slightly acid—when rubbed with carb. baryta a neutral salt obtained, which evaporated gave white salt of baryta which when heated did not fuse—flamed much and then left very charred ash. This was the first or most combustible salt of baryta—and this *lighter substance* is evidently Naphthaline holding a little of the peculiar acid in solution.

Heavier substance examined—solid—red—crystalline—soft like mixture of wax and oil—S. G. —taste very sour and bitter, little metallic. On foil burns with flame, fusing first, and leaves a bulky charcoal—suls. acid gas evolved—no residuum ultimately.

SUL. ACID AND
NAPHTHALINE.

Heated in tube—melts—then a deep clear red, almost opaque—further heat, naphthaline rose, a bulk[y] black substance remained—then suls. acid—charcoal left. Exposed to air it gradually became brown and damp and wet on exterior—dissolves in alcohol, solution brown. Rubbed in water, a deposit of naphthaline and an acid solution which when filtered was of a brown colour—180 gr. of the heavy solid gave 50 grains of Naphthaline—the rest soluble in water.

IMPURE NAPHTHA-
LINE ACID.

The filtered solution may be called *impure acid*—it contains sul. acid free when tested by Mur. baryta but not a great deal. When rubbed with native carb. baryta till neutral, the first filtrations or washing gave a white salt of baryta burning with flame, etc., being the *first or flaming salt*. The fourth and fifth washings of the residum of carbonate and sulphate of baryta when evaporated gave a small quantity of salt, but this when collected also burnt with bright flame—hence salt thus obtained must be nearly pure flaming salt. The washed carb. baryta, etc. when dried and heated did not blacken but seemed quite free from peculiar salts; hence probably that scarcely an atom of acid existing in *tindery* salt was formed.

1825. OCTR. 17TH.

SUL. ACID AND
NAPHTHALINE.

A portion of *heavy substance* put into a tube with some sul. acid and heated—at first floated but by agitation mixed perfectly, forming a deep red solution—left to cool—thickened but did not solidify or separate—a portion added to water, the *whole* dissolved—this rubbed with carb. baryta, etc. in mortar gave a mixture of which first washings gave by evaporation a salt burning with flame, but I think not quite so much so as *former flaming salt*—latter washings evaporated gave a salt which burnt tindery—was a little flame at one moment but principally tindery salt. The residuary carbonate and sulphate of baryta, no combustible matter in it. Hence by further action of S. A. it seems that a compound with less naphthaline is formed.

BAR. SALT IN
CHLORINE.

Flaming salt of baryta put into an atmosphere of chlorine containing perhaps one half air—left six hours, no action—salt unchanged and still soluble in water.

Now examine some of the SALTS of this acid. Ammonia added in excess to some of impure acid—evaporated—brown colour—filtered, became clearer but not colourless—evaporated to dryness—alcohol added to separate sulphate of ammonia—filtered—almost all dissolved—little sulphate on filter—solution tested by mur. baryta, no precipitation, hence salt pure—evaporated it by little warmth in air, became acid but dry—did not deliquesce by exposure to air—a little dissolved in strong ammonia and exposed to air became dry and slightly acid—litmus paper dipped in solution as it dried became very red—hence always acid salt—taste saline and cooling. Heated on foil—fused—blackened—burnt with flame and left a charcoal with acid sul. ammonia which by further heat had the sulphate decomposed in the usual way, and then ash entirely burnt away.

NAPHTHALINE—
AMMONIA SALTS.

Portion of the aqueous solution dried under air pump receiver—slightly or imperfectly crystalline—brownish—dry—in air not deliquescent—dissolves readily in water—acid to litmus, burns, etc. as before.

A very ammoniacal solution had litmus paper dipped into it, but before litmus had become dry at common temperatures had become acid and very red. The solution itself by standing became acid.

Potash added to solution of the salt liberates ammonia, and a salt of potash is formed which being less soluble precipitates in part if first solution strong enough.

Potash. Impure acid neutralised by crystd. carbonate of potash and pure potash—heated—brown—filtered—comes through nearly colourless—evaporated. As evaporating, the solution upon agitation easily admitted of the formation of floating globules, large and numerous—when dry, alcohol added—heated—filtered—scarcely any sul. potash left. Solution light brown—by spontaneous evaporation formed tufts of acicular crystals—salt white and transparent but becoming pearly in the air. It is soluble in water but not very much so—solution contains no Sul. Acid to M. Baryta—solid salt feels like greasy wax—soft but slightly fragile—exposed to air continues dry—solution in air dries up, hence not deliquescent, but still retains water—is slightly brown—the last washings by alcohol gave whitest salt—salt is neutral—

POTASH SALT.

NAPHTHALINE—
POTASH SALT.

bitter and saline to taste—heated on foil melts—blackens—then on cooling crystallises and is still neutral. Must dissolve, filter and examine this black substance—probably more pure—by further heat, fuses—decomposes—burns with flame—leaves much charcoal in ash and this by heat becomes alkaline—but in all cases smell of sul. hydrogen. A sulphuret is formed and this probably produces alkaline effect; either directly or in consequence of decomposition by carb. acid, etc., etc. The alcoholic solution—when hot exposed to air—gave crop of crystals platy and in tufts also as before. Examine salt successively during application of heat and ascertain when first begins to be alkaline.

1825. OCTR. 18TH.

SODA SALTS.

Soda. Impure acid as before, with carb. and pure soda—solution heated, evaporated and treated with alcohol—scarcely any sulphate of Soda. Alcoholic solution on cooling gave crystalline tufts, small, resembling those of *potash salt*. Evaporated to dryness—salt light brown—exposed to air did not deliquesce—solution (aqueous) in air became dry and crystalline—taste bitterish, not very strong, slight persistent metallic taste. Heated on foil—blackens a little—melts—puffs up—burns with flame and leaves a carbonaceous alkaline sulphuret soda—heated in a tube yields a little water—blackens—decomposes—fumes highly combustible—a little naphthaline evolved but perhaps not so much as with baryta or potash salts—then further action—sul. acid gas evolved with smell of sul. hydrogen. Query the soluble results after being strongly heated—if sulphur escapes, the residuum not a true sulphuret—perhaps a carbonate in part. Query also the escape of sulphurous acid gas—especially from salt of baryta as salt *remains* neutral and therefore retains *a proportion* of sulphur in acid.

OCTR. 19TH.

MAGNESIA SALT.

Magnesia. Impure acid rubbed with Magnesia—became neutral—evaporated—added Alcohol to dry salt—filtered—solution clear—slight colour—by spontaneous evaporation on glass plate gave separate tufts formed of radiating needles—very minute—evaporated to dryness by heat gave white salt—which on foil by heat

blackened—*fused*—swelled and burnt with flame—fuzing as it burnt—left black ash—*alkaline* to turmeric paper—black ash burned gave white ash, also slightly alkaline to turmeric paper. Are these effects due to pure magnesia or is some alkali present? In tube by heat—water, naphthaline and empyreumatic matter rose—black ash, etc.

NAPHTHALINE—
MAGNESIA SALT.

Aqueous solution by spontaneous evaporation left stratum of small radiated hemispheres resembling zeolite when seen through glass, and about it was an abundant vegetation beautifully prominent and relieved and highly crystalline—all quite dry—taste of salt bitterish but not eminently so.

Lime. Impure acid and marble rubbed together till neutral—a little concentrated—alcohol added—filtration—a solution obtained which by evaporation gave solid salt of lime—is moderately soluble in alcohol—in water not so soluble but is quite soluble by boiling. Alcoholic solution on glass left crystalline solid. Aqueous solution on glass, a white thick film which by lens slightly crystalline—by slow evaporation a disc of small crystals and an edge of vegetation—all dry—taste bitter, a little like sul. Mag.—a slight after metallic taste. Heated on foil—blackened, burned *without* change of form with bright flame—left black residuum, becoming white by degrees and proving to be sulphate of lime with little sulphuret of lime. In tube by heat—little water—blackening—then Naphthaline—then more action—denser fumes—yellow deposit—empyreumatic oil—then suls. acid gas? or pungent smell of some kind—left black ash, etc.

LIME SALTS.

Strontia. Impure acid rubbed up with native carb. strontia till neutral—filtered, etc.; aqueous solution evaporated gave a dry white salt—drops of aqueous solution on glass plates: rapid evaporation gave white film and ring—salt almost opaque by reflected light—not visibly crystalline, unchanging by exposure to air—slow evaporation gave —dry salt on platina foil heated—did not fuze—burnt with bright flame, smoke, etc.—no tinge of red in flame—left carbon and sulphate strontia, etc. In tube behaved like other salts, etc.

STRONTIA SALTS.

Iron—Iron filings in impure acid—action and liberation of hydrogen—heated a little and obtained a solution—greenish colour but slightly brown—acid to litmus—as the solution cooled it

IRON SALTS.

NAPHTHALINE—
IRON SALTS.

deposited a white salt of iron—crystalline but scarcely perceptible. The solution heated and removed from the Iron—part left in a clean tube to cool and deposit—drop of solution white by ferro prussiate potash becoming blue in the air—drops evaporated in the air spontaneously soon became covered with films—by slow evaporation left comparatively large globular concretions—were slightly brown—after standing exposed to air for 18 hours, water added gave a solution precipitating almost white by ferro prussiate pot. Aqueous solution evaporated by heat left similar substance which on foil burnt with flame without fusion or change of form—left charry ash which by heat in air gave suls. acid and left peroxide iron—taste of salt ferruginous—not bitter I think.

Alcohol 2 vols. added to 1 vol. aqueous solution—caused slight turbidness—filtered—slightly acid—by M. Baryta contained a little S. A.—drop of solution on glass by heat left crystalline film—almost white—left till mornng.—dissolved in water became more blue by ferro prussiate than upper aqueous solution. The alcoholic solution clear—white by ferro prussiate becoming blue by degrees—evaporated to dryness by heat a little separated red oxide appeared—dissolved in water—more blue to ferro pruss. than before. Drops of Alcoholic solution left on plates to evaporate all night—in mornng. films with aggregations here and there—light yellow colour—dissolved in water and tested by ferro prussiate more blue than dissolved drop from *aqueous* solution.

It would seem that a little acid remained uncombined—that a little per salt had been formed at first and dissolved in alcohol—that proto salt in alcohol becomes per salt by exposure to air or heat more rapidly than when dissolved in water—but that on the whole aqueous solution or the dry pure proto salt not very apt to change. The action of Alcohol here in causing oxidation something like its action on the two sulphocyanurets of Iron.

Make salt from pure acid and from sulphuret—sulphur and Iron moistened and heated a little. The proto salt seems considerably soluble in water.

ZINC SALT.

Zinc. Metallic zinc in impure acid—action and liberation of hydrogen—solution not neutral this way—added oxide of zinc by combustion and carbonate of zinc—boiled—filtered—evaporated considerably—then added alcohol to hot residuum—obtained

almost complete solution—but on cooling became almost gelatinous from formation of silky crystals of sul. zinc; these though bulk[y] very small in quantity—filtered—clear solution obtained—slightly acid and containing a little sul. acid to M. B.

NAPHTHALINE—
ZINC SALT.

Alcoholic solution on glass plate gave beautiful groups of crystals—star form with few rays—unlike all former salts—taste bitter—on foil fused—blackening—burning with much flame—black ash—burning to yellow white—residuum oxide of zinc. In tube, by heat, first little water—then naphthaline, suls. acid? and black ash.

Aqueous solution in drops on glass plate left small spherical groups of crystals not so distinct as with alcohol. A larger portion left all night, centre not well crystallised but an abundant vegetation fully and highly crystalline—silky, etc.

OCTR. 20.

Protoxide of mercury obtained by precipitating a proto nitrate by carbonate of soda, washing, etc. by decantation until pure but retained moist—this put in great excess into *impure acid sol.*—heated—evolution of some carb. acid—solution remained slightly acid—filtered and tested—potash precipitated black oxide of mercury. N. Baryta indicated a little common Sul. acid present.

MERCURY SALT.

Evaporated solution—soon became turbid and filmy—by continued heat a dry yellow salt obtained—having a little odour of naphthaline—the salt soluble in water forming yellow solution—by further heat colour increased to brown—still higher heat on plat. foil made it burn like tinder and ultimately nothing remained.

Another portion of solution somewhat concentrated put in drops upon a glass plate—as it cooled became turbid—filmy—left till morning—then each drop had left several small apparently hemispherical accumulations of salt—but not very decidedly crystalline—were dry—hence though acid salt not free acid.

Another portion of solution put in basin under air pump receiver to evaporate—left a white crystalline salt—in places yellow as if a little per salt or sub salt mixed with it—alcohol upon it warmed left a yellow salt—filtered—the yellow insoluble portion on platinum foil—burnt with little flame—tindery—all dissipated by mere heat. Alcoholic solution concentrated and

NAPHTHALINE—
MERCURY SALT.

dried by moderate heat gave yellow salt—this with water a yellow solution and more insoluble matter—the yellow solution with Mur. acid gave calomel.

Per oxide of Mercury obtained from per nitrate of potash—well washed, etc. etc.—digested moist in impure acid solution, boiling it for some time—filtered—solution clear acid—by concentration became pink colour and very acid but gave some peroxide to potash—drops on glass plate gave *damp* crystalline films—evaporated to dryness by heat left a yellow substance—at first brittle—but by exposure to air attracting water and becoming adhesive. On platina foil—fused, blackened—burnt with flame leaving no residuum—heated in a *tube* gave water—vapour naphthaline—mercury—emphyreumatic stain and left carbon. The yellow salt in water gave yellow solution and yellow sediment. The acid evidently in excess in solution hence not dry in the air.

Solution evaporated under air pump left a yellow solid—deliquescent in air from presence of free acid.

LEAD SALT.

Lead. Nitrate of lead precipitated by carbonate of soda, washed, etc. etc. The most carbonate digested in sol. of *impure acid*—effervescence—solution filtered—was clear, slightly acid—examined by sul. hydrogen, plenty of lead—by M. Baryta no sul. acid, for precipitate was flocculent and resolvable.

Drops left on glass plate left crystalline solid in radiating tufts—very crystalline and quite dry. A hot saturated solution on cooling deposited very white and pretty substance but not decidedly crystalline—feeling fatty or waxy.

Solution evaporated to dryness—white salt—taste bitter, metallic and afterwards saturnine¹—but not sweet—heated on platina foil blackened—fused—burned with much flame—left black mass which burnt giving suls. acid gas, metallic lead and ultimately oxide of lead. Salt heated in a tube, partial fusion—water—naphthaline—emphyreumatic results and charry ash.

Alcoholic solution of salt—drops on glass plate gave very crystalline results—platy—good salt for crystallizing—crystals feel dry—no adhering water. Salt considerably soluble in water.

MANGANESE SALT.

Manganese. Mur. Manganese and carb. soda mixed—the precipitated carbonate washed, etc.—digested whilst moist in *impure*

¹ Of or pertaining to Lead. (O.E.D.)

sol. of acid—evaporated to dryness—dissolved in water, filtered—
evaporated to dryness—dissolved in alcohol—filtered.

NAPHTHALINE—
MANGANESE SALT.

Alcoholic solution slightly brown—almost neutral but a little acid to litmus—drops on glass plate left aggregations of crystals radiating from a centre, but crystals so large as to prevent generally hemispherical form of aggregations—crystals distinct from each other. Evaporated by heat left a very light brown salt—slight austere taste—heated—first fuzing, then blackening and burning with flame—ash charry; by further heat with air charcoal burnt off and left *protoxide* of manganese—light brown whilst cold, dark brown whilst hot. Results in tubes as with former salts.

OCTR. 21.

Copper—Sul. copper and carb. soda—mixed—the carb. copper produced well washed, etc. and whilst moist digested in the *impure acid solution*—filtered. Solution—considerably acid—acid cupreous taste—greenish colour—on glass plate in drops left a very thick crystalline crust of radiated concretions—this a dry salt—very soluble (comparatively) in water.

COPPER SALT.

Salt on Plat. foil—becomes yellow brown—decrepitates considerably—blackens—fuzes—burns with flame leaving a mixture of charcoal, copper, etc.

Alcohol added to the salt—acid solution obtained—drops set aside to crystallize gave radiated agglomerations over the space of the drop surrounded by edge—decidedly crystalline—and dry. Portion in capsule left a dry crystalline result. The salt white or very nearly so.

Nickel. Sul. Nickel and carb. soda mixed—the carbonate precipitated, washed, etc. etc. This carbonate digested in impure acid—filtered, etc.—a green solution obtained which on being heated became slightly turbid—evaporated to dryness—alcohol added—a *green solution* obtained and a *white insoluble matter*—the latter heated on foil burnt tindery but did not char—left a white ash—it was insoluble in water but was in too small a quantity to have its nature well made out.

NICKEL SALT.

The *solution* in drops on glass gave a filmy space containing hemispherical crystalline tufts—tested by M. Baryta—no sul. acid

NAPHTHALINE— —evaporated to dryness—a *green salt*—by heat yellow, then brown
 NICKEL SALT. —not fuzing—charring—burning with much flame—leaving a black ash which by heat and air gave suls. acid gas and left oxide of nickel. In tube results as with former salts.

Hot *aqueous solution* cooled suddenly filled with minute acicular crystals—on plate of glass gave crystallization resembling that of alcohol, but no[t] so distinct—greater quantity of solution gave greater results but more confuzed.

SILVER SALT. *Silver*. Nitrate of silver and Carb. of Soda were well mixed and the precipitate well washed. A little of the precipitate dissolved entirely and readily in much of the impure acid. Excess of the carbonate of silver put and heat applied until neutral—filtered—a clear neutral solution obtained—brownish colour—taste highly metallic. Mur. Soda indicated much silver. Nit. Baryta—a little Sul. Acid. Drops of the solution on glass plate became quite dry in the air, crystallizing in tufts but not very distinct—the salt film very white and almost opaque by reflected light.

The *dry white salt* by heat—fuzes, darkening, a little blackens—decomposes—burns with flame, leaving a black residuum which by heat and air leaves silver—pure, spongy, very minutely divided, white and looking like a dense cobweb.

The *aqueous solution* boiled—it became less coloured and deposited *black films*, etc.; after a time this change ceased. The *deposition* separated and examined were of a dark gray colour—heated—it fuzed—blackened—burnt with a little flame but very tindery and left a carbonaceous residue burning to silver. The solution remaining by further concentration became almost gelatinous from the formation of a yellow salt in it—by evaporation the whole formed a light yellow-brown dry salt—this when heated, fused, became dark brown and inflamed—it left a black mass still fuzing—burning tindery—and rising up as it burnt so as to leave a [w]hole light cone of metallic silver.

The *dry salt* divided. *One half* dissolved in water only minute films left undissolved—drops on glass plate gave light brown films with concretions not distinctly crystalline. The *other half* in *alcohol*: a clear colourless solution obtained and an insoluble *yellow powder* left. The *yellow powder* separated—on foil blackened

—burnt tindery—no flame—and gave off suls. acid gas, leaving silver—it required much water to dissolve it, forming a solution which on evaporation again furnished the substance—drops of this solution left on plate glass left but little matter—that however highly crystalline in stars and needles, not mere tufts—similar results with a portion in a capsule—the residue was quite dry. Alcohol made it turbid and white.

NAPHTHALINE—
SILVER SALT.

The clear colourless *Alcoholic solution*—drops on glass plate—then films left—not very crystalline—were moist (from excess perhaps of acid). The rest evaporated became yellow and left a yellowish salt—heated on foil—fuzing—browning, burning with flame—leaving black residue burning to pure silver. This salt readily soluble in water with exception of a little yellow sediment—drops of solution left on glass plates left a light brown dry deposit—moderate in quantity, granular—apparently crystalline but not decidedly so.

OCTR. 22.

Flaming *baryta salt* and pure strong Nitric acid heated together in a tube for some time—little evolution of nitric oxide—remained opaque—matter did not dissolve. Added water and obtained a *bright yellow solution* and a *white insoluble flocculent matter*—not resembling sul. baryta but insoluble in very much water—filtered. *Yellow solution* gave baryta to sul. soda—evaporated, left yellow brown films soluble in water again—slightly acid and bitter to taste. The solid substance obtained by its evaporation heated on platinum foil—melted—blackened, burnt suddenly without flame—tindery—and left charcoal, burning to sulphate of baryta. The *white flocculent matter* by heat burnt tindery and left sulphate of baryta.

FLAMING BAR.
SALT IN N. A.

Strong N. A. on Napthaline—changes it—dissolves when hot, separates when cool—causes new combinations—a bitter soluble matter produced and an insoluble matter something like naphthaline, but containing an acid and by heat at last deflagrating. This action and results should be examined.

N. A. ON NAPHTHA-
LINE.

Flaming salt of baryta with N. M. Acid: similar results to those of N. A. Action very imperfect.

FLAMING BAR.
SALT: HEAT.

Flaming salt of baryta is decidedly neutral to litmus; not the slightest appearance of acid—yet heated in glass tube suls. acid gas as decidedly rises after the Naphthaline—the residuum from the tube heated in the air till white ash produced, then digested in M. A. gave little Sul. hydrogen smell—little nitric acid added—boiled—diluted, clear liquor tested—contained a little baryta. Hence suls. acid *may* have resulted from decomposition of sulphate of baryta or S. A. belonging to it by charcoal.

Some flaming salt mixed with little carbonate of baryta and then heated in tube gave *no* suls. acid vapours.

WITH SULPHUR.

Flaming salt and Sulphur mixed and heated—no particular action.

IMPURE NAPHTHA-
LINE ACID
ANALYZED.

Dry Naphthaline acid or *heavier substance* of Octr. 15—a portion of the purest taken—it equalled 151.4 *grains*. This rubbed in a mortar with water to dissolve the acid, care being taken of evening thin. It was filtered, the insoluble portion well washed and when dried by pressure was collected from the filter—introduced into a tube and fuzed with a sol. of mur. soda to effect its separation—when cold the solid matter was separated—wiped with bib. paper—and then weighed 39.6 *grains* and was *Naphthaline*.

A pure specimen of native carb. baryta was chosen, and being powdered 100 grains were weighed out, that being found more than sufficient to neutralise the acid solution—the carb. baryta and the acid were rubbed together in a mortar in small proportions and afterwards the whole heated together, the solution being neutral. Then the solution was separated from the insoluble portion, plenty of water being present to dissolve all barytic salt—and the *insoluble matter* was well washed untill pure, then dried and weighed, dried at 212° till it lost no more weight; it = 62.2 *grains*. It was then heated in a platinum crucible during which it became black or rather gray and burnt dully, diminishing in weight to 59.9 grains—a loss having occurred of 2.3 grains. It was then put into water and was found to be slightly alkaline and had films formed on its surface from the presence of baryta—probably sulphuret baryta from action of carbonaceous matter by heat on the sulphate—added a little nitric acid which caused slight smell of sul. hydrogen as carbonate dissolved—added weak Nitric acid until effervescence ceased and it was in excess—

filtered, washed the residue, etc., and found the sulphate of baryta when heated to equal 27 grains; about 33 grains therefore of Carbonate left untouched by acid.

COMPOSITION OF
S. A. AND NAPTHA-
LINE SUBSTANCE.

The solution of baryta salt was gradually evaporated in a basin weighing 2061 gr. until all was introduced and the salt had been obtained in the dry state—being scraped, pulverized on pan, etc. and heated until it ceases to loose weight, the pan was found to increase to 2178 gr. which, minus 2061 = 117 gr. of the salt in this state. It was immediately bottle[d] up, its weight being found to increase by exposure to air when cold—

Impure Napthaline acid	151.4 grains
Of this Napthaline separated	39.6
Hence Acid entering into combination	111.8
Carb. baryta used altogether	100.0
„ „ remaining unacted upon	34.8
„ „ converted into sulphate	22.9
„ „ „ peculiar salt	42.3
Quantity of sul. baryta produced	27.0
„ „ sul. acid it required	9.15
Hence Acid and water entering into peculr. salt	102.65
for Napthaline and Sul. Acid = ...	48.75
Quantity of baryta combining with peculiar acid	33
„ salt produced experimentally	117
„ „ by addition of acid and baryta	135.65
Hence water driven off	18.65

and as some still remains crystalline impure acid must contain much.

O C T R. 23.

30 grains of the salt thus produced burnt in plat. crucible till white left 13 gr. residum—sul. acid added—heated to drive off excess—weighed again still 13 grains exactly of sul. baryta from the 30 original salt.

FLAMING BAR.
SALT—QUANTITY
OF SUL. BARYTA.

30 grains of the same salt mixed with 20 gr. carbonate in fine powder—burnt in crucible till white—a little nit. amm. added, but perceiving smell of sul. hydrogen water was added, the whole put into a basin and left to oxidize in the air.

Some of the bottom portion of lower stratum examined as to proportion of *tindery salt* given by it—treated with carb. baryta gave much flaming salt—but also some tindery salt—more tindery salt than upper portion though not a great deal compared to the flaming salt produced.

IMPURE SOLID
ACID.

OCTR. 27TH.

A portion of heavy or lower stratum retained melted in a tube in water bath for some hours undisturbed—on cooling examined—at top a little of lighter or naphthaline substance—below the heavy substance. Portions of this taken, one from top, another from bottom and examined as to relative quantity of first and second acid by making barytic salts—gave about equal proportions of naphthaline. Top portion gave hardly a trace of tindery salt—residuum burnt tindery and some of that kind of salt there. Bottom portion also gave much flaming salt and but little tindery salt—perhaps a little more than top portion but quite doubtful.

Flaming salt of baryta dried in tube at 350° – 400° for 40 minutes—then tube cooled—salt had not decomposed or suffered—then heated; Naphthaline rose pure—then carbonization, etc. etc.—fumes—very minute trace of water if any—doubtful if small portion at last were not from action of hydrogen on the S. A., for decided smell of sul. hydrogen produced.

FLAMING BAR.
SALT—DRIED.

OCTR. 28.

4.2 gr. of baryta salt dried at 450° (flaming salt) exposed to air in a capsule—till Nov. 4th—had become 4.4, increase of 0.2.

CRYSTD.—HYGRO-
METRED, ETC.

A cold saturated sol. of barytic salt set aside Octr. 12th covered with paper to crystallize. Today (Oct. 28) examined—several groups of crystals in remaining solution—the crystals decidedly formed—transparent—but not perfect enough to give shape—best yet obtained—pressed, dried and burnt on plat. foil gave scarcely any flame but burnt *tindery*.

Flaming salt of baryta in a tube in metallic bath—at 480° – 500° for half an hour—water was driven off but no naphthaline sublimed—no blacking or discolouration—at 480° a card and paper browned and rendered brittle—at 570° began to brown—but very little naphthaline had risen and salt in this state burnt with as much

FLAMING SALT
BARYTA AND HEAT.

FLAMING SALT
BARYTA AND HEAT.

flame as before apparently. The second or tindery barytic salt also began to brown at 570° —left at 570° – 560° for half an hour, no further change—then heated by spirit lamp, no water rose—a little naphthaline but very little indeed—fumes—blackening, etc. *First or flaming* salt also left for same time—then heated in tube—plenty of naphthaline during decomposition.

Hence cannot convert flaming salt into tindery salt by heat. Hence also hydro carbon held down very powerfully.

OCTR. 29TH.

SUL. ACID AND
NAPHTHALINE.

Some naphthaline and sul. acid rubbed together in a mortar cold and left for several hours—exposed to air—then when rubbed with carb. baryta gave a little flaming salt—very little of tindery salt—indeed very little altogether. No advantage in proportion of tindery salt.

Some Naphthaline rubbed with S. A., then put into a tube—heated—a little more naphthaline added—heated and agitated—the proportions were such that a homogeneous red fluid resulted remaining fluid when cold but thick like treacle—the mixture was not heated longer than sufficient to combine the substances. Examined for salts in the usual way gave very much flaming salt and scarcely any tindery salt.

Some Naphthaline and sul. acid rubbed in a mortar put into a tube with some more naphthaline—heated and mixed—the heat was higher and continued much longer than in last experiment—the proportion of naphthaline was also larger, so that though a uniform fluid whilst hot, on cooling it crystallised—much more acid in it however than in what has been called *heavy portion*. Then examined for salts in usual way gave very much flaming salt and scarcely any tindery salt—not better or worse than last experiment. Hence tindery salt seems formed almost accidentally and cannot be made in these ways at pleasure to the exclusion of flaming salt. Hence also action and combination at common temperatures.

QUANTITY OF
HYDROGEN FROM
ZINC.

Expt. for Phillips.

81.5 gr. of metallic zinc gave with S. A. 122 c: i: of gas. This is too much and gives No. of zinc 31.5 instead of 35?

Bone oil from Mr Crane—Crude, Black, fetid, very ammoniacal. Distilled in tin vessel—a moderate temperature sent over a quantity of ammoniacal liquor and some thin light volatile oil, but afterwards produced no more effect. Heat raised more highly—at last began to distil plentifully, but heat such as to char a cloth wrapped round leaden tube conducting the vapour. The results were received in separate portions and the last portions when cold were much darker and thicker than first portions—crystals appeared in upper part of some of bottles, probably carb. ammonia, and in the last portions sediments of a different nature apparently were formed. It is remarkable that ammonia came over to the last, hence must have been some compound of azote bearing a high temp. in the still though gradually decomposed. The distillation was continued till fumes came over with the vapour, these fumes being incondensable and either a gas or a very volatile substance formed by the action of heat on residuum.

BONE OIL DISTILLED.

Specimens of the products were taken for future examination—
No. 1—Ammonia from distillation.

2—First product with ammonia at temp. 212° or 220° .

3—2nd product

4—3rd „

5—4th „

6—5th „

7—6th product

8—Residuum left in tin retort.

} received in succession at higher temperatures.

See Sept. 29, 1827.

1825. N O V R. 15TH.

A piece of pure transparent and colourless caoutchouc which had been washed before aggregation many times cut into thin slips and charged carefully into tubes in following experiments so as to have plenty of oxide of copper about them.

PURE CAOUTCHOUC
OVER OXIDE OF
COPPER.

Caoutchouc = 1.2 grains.

Tube when charged = 399.38 gr.

Loss of weight of tube by heating = 4.16 gr. (carb. acid)

Further loss of weight by driving off water = 1.4

Gas. In first or thinner tube = 5.3 c.i. : } correctly { 5.13 = 8.67
„ „ second or shorter tube = 3.6 } { 3.54

PURE CAOUTCHOUC
OVER OXIDE OF
COPPER.

Potash added left in first tube 0.4 c: i: and in second tube 0.02 c: i: = 0.42 c: i: residual gas—as no nitrogen in second tube there can be none in the substance, residual gas being merely air of tube expelled by c: a:

The tube now dismantled—its contents rubbed up together, restored—tube rearranged and again heated to redness—not quite 0.3 c: i: of gas were obtained, in which potash caused no absorption—loss of weight in the tube was hardly visible—when asbestos heated a little water came out amounting to 0.2 grains—this was probably from the additional oxide of copper which had been put in unheated and this probably forming vapour had expelled so much as 0.3 c: i: of air.

PURE CAOUTCHOUC
ANALYSED.

The tube was now allowed to cool entirely, then reheated to ascertain how much air would be forced out by mere expansion; it equalled 0.1 c: i:

Corrections { Long narrow tube—6.2 c: i: really only 6 c: i:
shorter wider tube—6.1 c: i: „ „ 6 c: i:

Caoutchouc 1.20 grains

Loss of Carb. acid from tube . 4.16

Loss as water 1.40

Carbonic acid 8.41 cubic inches

Do. in calculated weight 3.92 grains

Carbon in the Carb. acid 1.0691 } or { 6.875 or { 9 Proportionals.
Hydrogen in water . 0.1555 } 1 } 8

Weight of elements surpasses weight of substance used. Inasmuch as the tube remains filled with carbonic acid and vapour and they must be in nearly equal volumes, the quantity of carb. acid remaining in it must be nearly 0.16, which added to the C. A. received = 8.41; hence the assumption of that quantity.

1825. NOV. 17TH.

PURE CAOUTCHOUC
OVER OXIDE OF
COPPER.

Pure caoutchouc = 1.2 grains.

Tube and contents = 515.5 grains (same tube as before)

Loss of weight in tube = 3.88 gr.

Water driven off = 1.31 gr.

Gas in long narrow tube = 5.5 c: i: } corrected { 5.32
„ „ short wider tube = 2.47 } 2.43 = 7.75

Potash left in short wide tube (the first used) 0.26 c:i: and in the long narrower one 0.05 c:i: = 0.31 unabsorbed.

Caoutchouc	1.20 grains		
Loss of weight in tube (C. A.)	3.88		
Loss of weight—water	1.31		
Carb. acid gas	7.54 c:i:		
Do. in calculated weight	3.51364 gr.		
Carbon in it	0.95826	6.582	10
Hydrogen in water	1.4555	or 1	9 prop.

PURE CAOUTCHOUC
OVER OXIDE OF
COPPER.

1825. NOV. 19TH.

Pure caoutchouc 1.45 gr. In this experiment a glass tube containing dried chloride of lime was interposed in arrangement between asbestos and moveable pieces, being joined by caoutchouc tube—the asbestos however cooled as usual.

PURE CAOUTCHOUC
ANALYSED.

Pure caoutchouc	=	1.45 gr.	
Tube and contents	=	508.74 gr.	
Drying tube and contents	=	57.2 gr.	
Loss of weight in main tube	=	4.7 gr. (carb. acid)	
Water driven off, then its loss	=	1.5 gr. (water)	
Drying tube had increased only	=	0.04 gr.	
Gas in short wide tube (the first)	=	7 c:i:}	cor-
„ long narrow tube	=	3.95 c:i:}	rected
By potash first tube left 0.4 c:i: and the second 0.02 c:i: = 0.42 gas or air uncondensed. This large in consequence of additional air of drying tube.			$\left\{ \begin{array}{l} 6.885 \\ 3.822 \end{array} \right\} = 10.707$

Novr. 21st. Contents of this tube taken out, repulverised and mixed—repacked again and reheated; 0.21 c:i: of gas received—tube allowed to become quite cold but its contents not disturbed; then reheated, etc. gave off 0.2 c:i:; hence this the quantity thrown by expansion out of heated part of the tube.

Caoutchouc	1.45 gr.		
Loss of weight in tube	4.70		
Loss of weight, water	1.50 gr.		
Water in drying tube	0.04 gr.		1.54 water
Carb. acid gas	10.507 c:i:		
Do. in calculated weight	4.89626 gr.		
Carbon in it	1.335344	or	$\left\{ \begin{array}{l} 7.8 \\ 1 \end{array} \right\} \begin{array}{l} 4 \\ 3 \end{array} \text{ Proport.}$
Hydrogen in water	1.71111		

PURE CAOUTCHOUC
OVER OXIDE OF
COPPER.

no drying tube used.

Pure Caoutchouc . . . = 1.38 grains.

Tube, etc. = 527.3

Loss of weight in tube . = 4.3

Loss on driving off water = 1.53: tube broke and a small piece of asbestos lost—very trifling.

Gas in tall narrow tube = 5.3 c: i: } corrected { 5.13
,, short wide one = 4.5 c: i: } { 4.426 = 9.556

Potash left 0.35 in tall tube—and a very minute bubble in shorter one.

Caoutchouc = 1.38 gr.

Loss of weight in tube . = 4.30

Loss of weight—water . = 1.53

Carb. acid gas = 9.336 c: i:

Do. by calculated weight = 4.35

Carbon in it 1.1865 } or 6.98 7 proportionals.
Hydrogen in water 17 } 1 6

Mean of four expts.

Carbon 7.06 } { 7 proportionals.

Hydrogen 1.00 } { 6 Do.

Mean of three best expts:

Carbon 6.812 } { 8 proportionals.

Hydrogen 1.000 } { 7 Do.

1825. NOV. 21ST.

CAOUTCHOUC
HEATED—DIS-
TILLED, ETC.

Pure caoutchouc heated in glass tube—first melted—then distilled over without any further change, having only a slight colour—by heating a part of the tube red where the vapour lay it was gradually further decomposed and carbon deposited.

Some oxide of copper put into some of this fluid—the fluid by heat distilled from off the oxide of copper without decomposing it or depositing carbon—hence reason why there is no occasion to repulverise contents of the tubes in analytical processes.

Moderately pure caoutchouc distilled—no gas—all fluid products though some very volatile—received together—were a fluid comparatively liquid smelling like naphtha—lighter than water—insoluble in water—unaffected or nearly so by solution of potash—soluble in alcohol but only in small quantity—solution precipitated by water—very soluble in fixed and volatile oils.

CAOUTCHOUC
HEATED—DIS-
TILLED, ETC.

A portion boiled with a thermometer in a tube began to boil at 80° F. and continued boiling up to 560° and then much left requiring a higher temperature.

The liquid rectified from off carb. of lime and products received in different portions—first portions very volatile but small in quantity—most abundant about 400° or 450°.

S. A. added to a portion of general mixture—instantly combined—deep red solution and heat evolved—water added caused precipitation with separation of dark coloured adhesive matter—smell like that of similar action with oil gas products—diluted acid treated, part with carb. baryta and part with carb. potash—a very minute portion of sol. salt obtained in first case and no pearly salt in second.

S. A. WITH
CAOUTCHOUC
PRODUCTS.

NOV. 23RD.

All the products of yesterday's distillation fluid: not thick or tenaceous—the most volatile most fluid. Cooled to 0° F, the first, second and third portions remained quite fluid—the fourth a little thickened—the fifth still thicker like thin tar perhaps—on rising to 50° *all* fluid again.

CAOUTCHOUC
PRODUCTS.

Slip of pure caoutchouc put into very strong solution of potash (solid when cold) and boiled with it—no action except production of pearly or tendinous surface on caoutchouc—no softening or swelling.

CAOUTCHOUC IN
POTASH.

A slip of pure caoutchouc in pure nitric acid—heated—caused evolution of nitrous acid and at last it dissolved and a yellow solution resulted which on cooling became turbid—water precipitated a yellow body—the acid solution evaporated left a bright chesnut brown substance insoluble in water—soluble in part in alcohol solution—precipitated by water—alcoholic solution on glass plate left a yellow deposit.

IN N. A.

S. G. OF CAOUT-
CHOUC.

Alcohol diluted until slip of pure caoutchouc just floated in it—this alcohol compared with water. Water 390.42—the Alcohol 360.18—S. G. of Alcohol 0.925; hence S. G. of pure caoutchouc 0.925.

NOV. 24TH.

CAOUTCHOUC
PRESSED.

Pure caoutchouc wrapped up until thick, then pressed in Bramah's press—when expanded folded up again and repressed—folded up in this way several times until it refused to extend laterally, then very much pressed—no alteration had taken place in its S. G. but it was more rigid and stiff.

PURE CAOUTCHOUC
WITH SULPHUR.

Pure caoutchouc and sulphur heated in tube—peculiar results of decomposition: much gas and vapour containing sulphur, carbon and hydrogen—much charcoal left in tube—this not left if caoutchouc distilled per se.

Caoutchouc (pure) with sulphur in considerable excess—the products received over water—much sul. hydrogen came over but no other permanent gas—the retort contained sulphur and carbon; by driving off the sulphur the carbon left alone.

Pure caoutchouc with deficiency of sulphur—gave sul. hydrogen—a volatile compound of carbon and hydrogen burning brightly—other more fixed compounds like those from caoutchouc alone and ultimately charcoal remained. The sulphur seems simply to take the hydrogen.

A little sulphur put into product No. IV of Nov. 22—slight heat caused its solution—yellow liquid resulted—on cooling sulphur crystallised out abundantly—mixture heated continuously—sulphur gradually acted producing sul. hydrogen and darkening the colour of liquid until all exhausted—the remaining liquid then distilled in the tube without further change. On adding a little more sulphur, action recommenced again by heat—more sul. hydrogen produced and further darkening of liquid—when the sulphur was exhausted there was again cessation of action. Added sulphur a third time—renewed liberation of sul. hydrogen and now thickening and solidification of fluid, charcoal beginning to separate in the solid form—a little volatile compound of carbon and hydrogen seemed to form now and then at this period ac-

cording to the heat and dryness of the mass and burnt with bright white flame—ultimately charcoal only left in the tube. PURE CAOUTCHOU WITH SULPHUR.

Sulphur in No. 1 or most vol. product—liquid did not bear heat enough to effect decomposition, but volatilized—it did not seem either to dissolve any or but little sulphur—the sulphur heated in its vapour decomposed it as before.

Hints, etc. { *Process for Sul. hydrogen*—Sulphur and Naptha or tar or pitch, etc.

Test of presence of hydrogen—heat with sulphur?

To make more carburetted compounds for experimental combination—remove part of hydrogen by sulphur.

Pure caoutchouc in No. 1 or vol. product—dissolves readily—viscid solution—in air rapidly dries and leaves caoutchouc. The same or similar results in the other products. CAOUTCHOU IN PRODUCT.

Drops of No. 2 on glass rapidly evaporated when warmed leaving thin film on glass. No. 3 also evaporated but more slowly, leaving an slight and adhesive film—No. 4 though warmed did not dry in several hours.

Clean pure Potassium has no action on well rectified products. POTASSM. IN DO.

No gaseous products are evolved during moderate distillation of caoutchouc and its conversion into fluid products. CAOUTCHOU DISTILLED.

1825. NOV. 28TH.

Experiments on induction by connecting wire of voltaic battery. A battery of 4 troughs, ten pair of plates each, arranged side by side. ELECTRO MAGNETIC INDUCTION.

Expt. I. The poles connected by a wire about 4 feet long, parallel to which was another similar wire separated from it only by 2 thicknesses of paper. The ends of the latter wire attached to a galvanometer exhibited no action.

Expt. II. The battery poles connected by a silked helix—a straight wire passed through it and its ends connected with the galvanometer—no effect.

Expt. III. The battery poles connected by a straight wire over which was a helix, its ends being connected with the galvanometer—no effect.

Could not in any way render any induction evident from the connecting wire.

ELECTRIC INDUC-
TION.ANALYSIS OF
FLAMING BAR-
SALT.

Expts. on Electric induction in imitation of Arago's experiment on rotation of magnets.

A Deluc's column dried and got into good action suspended horizontally by 5 feet of silk thread, then a plate of copper whirled beneath it—no action.

A small Leyden jar mounted with an external wire bent and arranged as in the sketch was suspended as before, and being charged the knobs or balls were one positive and the other negative. The copper plate being whirled beneath, no effect was produced except such as was due to the wind of the plate.

DEC R. 13TH.

Some of the barytic salts have been prepared by repeated crystallization, etc. so as to furnish pure flaming and pure tindery salt.

These have been dried in glass tube by immersing them in a metallic bath at temperatures from 440° to 480° for about 3 hours.

The dry flaming salt analysed by oxide of copper being mixed with it with proper precautions, etc.

Dry flaming salt 3.16 grains.

Tube when charged 411.57 gr.

„ lost by operation 4.93 gr.—carb. acid

„ „ after heat 0.80 gr.—water

Gas in tall narrow tube 5.1 c: i:, correctly 4.935, left by potash 0.28 c: i:

Gas in short wider tube 5.66 c: i:, correctly 5.57, left by potash minute bubble.

Carbonic acid gas = $10.365 \text{ c: i:} = 4.83 \text{ grains} =$

Carbon = 1.317 gr.

Hydrogen = 0.090 „, i.e. Water collected 0.8 gr.

Baryta = .88424

Sul. Baryta = 1.3377

Salt used = 3.160 gr.

S. A. = .45346

Again another expt., same salt:

Dry flaming salt 3.23 gr.

Tube charged weighed 416.70

„ lost by operation 5.09 carb. acid.

„ „ heat afterwards 0.86 water.

Gas in tall narrow tube 5.3 c: i:, correctly 5.13, left by potash
0.3 c: i:

Gas in short wider tube 5.73 c: i:, correctly 5.545, left mere
nothing.

Gas in these experiments pure carbonic acid—no suls. acid gas.

Carbonic acid gas . . . = 10.525 c: i: = 4.9 grains =

Carbon . . . = 1.33763 gr.

Hydrogen . . . = 0.09555 „ i.e. water 0.86 gr.

Baryta . . . = .90385

Sul. baryta . . . = 1.36736

Salt used . . . = 3.23

S. A. . . . = 0.46351

ANALYSIS OF
FLAMING BAR.
SALT.

Six grains of this same salt exposed to air for 24 hours increased
0.2 gr.; these by burning, sul. acid, etc. gave 2.5 grains sul.
baryta or 10 gr. gave 4.1666.

1825. DE CR. 14.

Six grains of the same salt (same specimen) by heat and
sulphuric acid gave 2.54 gr. of sulphate baryta—this therefore the
baryta—or 10 gr. gave 4.2333 gr. sulphate—BEST.

Another Six grains mixed with 4 gr. carb. baryta put into tube
and covered by 4 gr. more carbonate—heated; much Naphthaline,
some sulphurous acid—small trace only—a little empyreumatic
oil, black, etc. but on cooling crystallised principally naphthaline.
The matter remaining put into water, boiled with excess of Nitric
acid to dissolve carbonate, filtered, washed, etc. gave 3.05 of the
sulphate of baryta—or 10 gr. gave 5.0833 sulphate.

Nine grains of the same salt put into a tube covered with
pulverised carb. of lime (marble)—heated in Cooper's apparatus—
much naphthaline, etc., no suls. acid to nose—put the residuum
into water, added nitric acid to convert all into sul.-c. acid that
could be, added Mur. baryta and then collected the sulphate of
baryta formed; it equalled 4.04 grains or 10 gr. gave 4.4888 gr.
sulphate.

1825. DE CR. 15TH.

Tube with some of the same specimen of flaming salt used in
the last experiments was introduced again into metallic bath and

FLAMING BAR. SALT
DRIED: ANALYSED.

FLAMING BAR. SALT
DRIED: ANALYSED.

heated for two hours between 480° – 530° ; then it had odour of naphthaline and had lost 0.7 of a grain—the original quantity being 10.58 grains.

A portion of this salt thus excessively dried analyzed:

Salt	3.16 gr.
Tube when charged . =	414.8 gr.
„ lost by operation	4.72 gr.
„ „ heat . .	0.80—water
Gas in short wide tube =	4.25 c: i:—correctly 4.113, by potash left nothing.
Gas in long narrow tube =	5.97 c: i:—correctly 5.780, by potash left 0.3 c: i:
Carbonic acid gas . . =	9.763 c: i: = 4.5495 gr. =
Carbon	1.2408 gr.
Hydrogen	0.09—i.e. water collected 0.8 gr.
Baryta	0.943
Sul. baryta	1.42663
Salt used	3.16 gr.
S. A.	.48363

A specimen of the flaming salt before it was dried in tube in metallic bath and as it came from sand bath (pure white, etc.):

Salt	3.5 grains.
Tube charged weighed	428.14 gr.
„ lost by operation	5.64
„ „ heat . .	0.90 water
Gas short wide tube =	6.38 c: i:; correctly 6.275, left by potash 0.0.
Gas long narrow tube =	5.80 c: i:; correctly 5.613, left by potash 0.3 c. i.
Carbonic acid . . =	11.738 c: i: = 5.47 grains =
Carbon	1.4918 gr.
Hydrogen	0.1000—i.e. water 0.90 gr.
Baryta	0.9650
Sul. baryta	1.4600
Salt used	3.5000
S. A.	0.4950
Oxygen	

Seven grains of the same salt burnt and by Sul. acid gave 2.92 grains sulphate baryta—or 10 gr. salt gave 4.1714 sulphate.

FLAMING BAR. SALT
DRIED: ANALYSED.

1825. DE CR. 17TH.

Tindery salt, a pure crystalline specimen, dried in metallic bath in a tube for 3 hours from 440° to 480° F.

TINDERY BAR.
SALT ANALYSED.

10 grains of this salt exposed to air for 40 hours increased 0.08 of a grain only—these heated in a platinum crucible gave some bright flame—hence some hydrogen—the residum very carbonaceous—the carbon burnt away and the baryta made into sulphate by addition of sul. acid and heat gave 4.24 gr. sulphate of baryta.

Salt analyzed by oxide of copper.

Salt 5 grains.

Tube charged . . . = 412.2 gr.

„ lost by operation = 7.84 gr.

„ „ heat . . = 1.20 gr.—this water.

Gas in short wide tube = 6.7 c:i:, correctly 6.59 c:i:, left by potash nothing.

Gas in long narrow tube = 6.48 c:i:, correctly 6.27, left by potash 0.3 c:i:

Gas in long narrow tube = 4.10 c:i:, correctly 3.968, left by potash nothing.

Carbonic acid . . . = 16.678 c:i: = 7.772 grains =

Carbon = 2.119622 gr. 2.11962

Hydrogen = 0.1333—i.e. 1.2 water . . . 0.13330

Baryta = 1.4 1.40000

Sul. Baryta = 2.12 S. A. 0.72000

Salt used = 5.0 Oxygen 0.62708

5

1825. DE CR. 22ND.

16 grains of the flaming salt analyzed Decr. 15th introduced into a dry retort, chlorine admitted and the substance heated until decomposed—then retort taken from its cap and alcohol introduced for the purpose of dissolving all the naphthaline and triple chloride of carbon and hydrogen and letting the S. A. and baryta act upon

FLAMING SALT IN
CHLORINE—
ANALYZED.

FLAMING SALT IN
CHLORINE-
ANALYZED.

each other, a little N. A. also being introduced to facilitate this action; left all night—next morning Mur. Baryta added and agitated—insol. matter washed first with alcohol then with water, left Sul. bary. and charcoal and these by heat and S. A. in crucible gave Sul. baryta 6.3 gr. The alcoholic sol. evap. to dryness, the watery washing being also added to it. The dry mixture heated in crucible to decompose triple chloride carbon and hydrogen—the residue washed with water to remove mur. baryta, etc., the insoluble residue by heat and S. A. gave 0.9 sul. bary. Hence Sul. acid of whole substance gave or was equivalent to 7.2 sul. baryta.

Flaming salt in chlorine gas—no action whilst cold—heat applied, little action, imperfect charring—afterwards examined, water being poured into the retort—a solution obtained which when filtered and tested by Mur. Baryta contained sulphuric acid. The insoluble matter contained a yellow triple hydro chloride of carbon and a dark carbonaceous heavy substance—this by M. A. gave a solution which tested by sol. soda evidently contained baryta. Hence perhaps the first sul. acid (by water alone) not excess of acid, but such as this baryta had previously been combined with.

Sulphur mixed with flaming salt—mixture heated in a tube. At first Naphthaline rose—then colour of residuum changed to deep brown—some suls. acid gas rose and ultimately sul. hydrogen—a carbonaceous sulphuret of barium was left behind.

DEC R. 28TH.

10 grains of a flaming barytic salt nearly free from tindery salt gave 4 gr. of sulphate of baryta by heat and Sulphuric acid.

10 grains of the same salt heated and boiled in a flask with strong N. M. Acid; it did [? was] not all dissolved but there was action (strong)—after a time added some sol. mur. baryta and then boiled to dryness in the flask—washed out all with water—evaporated to dryness—heated solid product in platina crucible—it *deflagrated* a little—fused the result—washed the residue with water and pure M. A. in order to remove all carbonate and muriate of baryta—the insoluble portion well washed, dried and heated equalled 6.5 grains sul. baryta, and by filtering the washings, etc. 0.7 of a grain more sulphate was collected, making 7.2 in whole.

This very different to above, but must analyse it by ox. of copper and ascertain Sul. acid that way.

General statements (comparative) of analyses of salts.

Flaming salt dried at 460°.	Carbon	1.31700—4.16772—116.2	—19.4	Prop.
	Hydrogen	0.09000—0.28481—	7.94—	8
	Oxygen	0.41530—1.31424		
	Baryta	0.88424—2.79780—	78	— 1
	Sul. Acid	0.45346—1.43563		
		<u>3.16</u>	<u>10.</u>	
Flaming salt dried at 460°.	Carbon	1.33763—4.14127—115.4	—19.2	
	Hydrogen	0.09555—0.29583—	8.24—	8 $\frac{1}{4}$
	Oxygen	0.42946—1.32960		
	Baryta	0.90385—2.79830—	78	— 1
	Sul. acid	0.46351—1.43501		
		<u>3.23</u>	<u>10.</u>	
Flaming salt ex- cessively dried.	Carbon	1.24080—3.92660—102.63—	17.1	
	Hydrogen	0.09000—0.28481—	7.44—	7 $\frac{1}{2}$
	Oxygen	0.40257—1.27400		
	Baryta	0.94300—2.98417—	78	— 1
	Sul. Acid	0.48363—1.52848		
		<u>3.16</u>	<u>10.</u>	
Flaming salt dried on sand bath.	Carbon	1.4918 — 4.26230—120.58—20	—120.58—20	proportionals
	Hydrogen	0.1000 — 0.28570—	8.08— 8	— 8.08— 8 Do.
	Oxygen	0.4482 — 1.28057—	—	— 36.23— 4 $\frac{1}{2}$ Do.
	Baryta	0.9650 — 2.75714—	78 — 1	— 78.00— 1 Do.
	Sul. acid	0.4950 — 1.41428—	—	— 40.00— 1 Do.
		<u>3.5</u>	<u>10.</u>	
Tindery salt dried at 460°.	Carbon	2.11962—4.23924—118.09—	19.6	
	Hydrogen	0.13330—0.26660—	7.426—	7 $\frac{1}{2}$
	Oxygen	0.62708—1.25416		
	Baryta	1.40000—2.80000—	78	— 1
	Sul. acid	0.72000—1.44000		
		<u>5.</u>	<u>10.</u>	

In these results the acid has been assumed as an equivalent to the baryta and consequently the oxygen assumed as the deficiency.

If the acid is found to exist in rather larger quantity than the equivalent the oxygen must be proportionally diminished. The *Carbon, Hydrogen and Baryta* are *experimental results*.

1825. DE CR. 31.

The pure solid acid imperfectly soluble in Naphthaline, oil of turpentine, olive oil, etc., less in naphthaline than in the others. Contains water still and that probably the cause.

Pearly salt of potash dissolved in water—alcohol added—it precipitated the salt which being collected, dissolved and crystallised was *not pearly*. The solution evaporated gave a brownish matter burning with flame and a peculiar smell. This matter soluble in water and when common sulphate of potash added to it, a solution obtained which gave on evaporation *very pearly crystals*. Hence properties of these pearly salts due to a distinct kind of matter.

A little Naphthaline salt of potash added to common sul-potash, the whole dissolved and crystallised; no union or production of pearly salts.

Flaming barytic salt dissolved in Baryta water boiled for some hours. Carb. acid then thrown into flask and shaken to precipitate the baryta (free)—filtered—solution neutral—clear—not affecting test papers, etc. or carb. acid—evaporated gave the salt unchanged, flaming as ever. Hence tindery salt not a sub salt or the tindery salt formed by action of Carb. baryta.

Expt. repeated; same results.

S. G. of impure solid acid 1.3; another specimen 1.4.

Napthaline and S. A. heated together considerably until mixture had lost red colour and taken green one—much suls. acid had been given off and the mixture did not become solid on cooling. Half of this was dissolved in water—no precipitate on solution—half of *the solution* treated with carb. baryta gave with first washing Dully flaming salt not at all like pure flaming salt—2nd washing much more tindery—3rd washing very tindery—4th washing almost pure tindery salt. The other half of *the solution* boiled to drive off the sulphurous acid, then rubbed carb. baryta; seemed to form but little insoluble salt; 1st washing removed mixed salts; 2nd very tindery indeed.

The remaining half of the strong acid left above heated still more; more suls. acid came off and some naphthaline when cold—thick, not solid—colour dark green—by dilution no precipitate. Rubbed with Carb. baryta, 1st and 2nd washing gave mixtures, third washing almost all tindery. The effect of the further heat here not very decided.

1826. JAN Y. 2.

Again Naphthaline in great excess and S. A. heated in tube; much naphthaline came off not being retained either by affinity or alteration. The residue heated considerably but not to charring, only dark green. Half of this was removed and allowed to cool; the other half had S. A. added to it until the acid doubled, then heated almost to charring and left to cool. The first half when cold was very hard, much harder than naphthaline, more like asphaltum—black also—water dissolved the whole with exception apparently of a little very finely divided charcoal, which made the solution black, but there was no appearance of solid matter. It filtered black and unchanged. Rubbed with carb. baryta gave a tenaceous black mixture; this heated a little soon cleared from bubbles—became neutral. The first liquid filtered was very dark coloured and on evaporation gave a salt very tindery, but still a little flame. The second more tindery still, better than any former if it can be rendered white.

The other half (excess of S. A.) when cold a thick tarry black mass—added to water black and more carbon perhaps than before. Rubbed with carb. baryta, required heat to assist—when neutral, first washing gave tindery salt but it was very dark coloured as it evaporated—film of extraneous matter appeared to separate. Both these too dark.

Flaming salt of baryta digested in Alcohol and filtered. The salt left undissolved was as flaming as ever. Hence alcohol [did] not decompose it or abstract any thing like naphthaline from it. The Alcoholic solution evaporated gave a little yellow white salt—by heat fuzing, burning tindery, but with a little flame. Its quantity was very small. It left sulphate of baryta. The flaming salt seems very little soluble in alcohol, the tindery salt a little more.

Naphthaline and S. A., 1 vol. former, 2 vols. latter, heated in

tube till dark green, immediately added to water gave a dark solution—no deposit—but carb. baryta just cleared it of colour. The solution obtained was almost all tindery salt.

It seems that when 1 vol. naphthaline and 2 S. A. are mixed together and heated as much as may be without charring, so that the solution immediately made shall give colourless sol. with baryta, that then most tindery salt is formed. It also seems that then but little sulphate comparatively is formed. It is best to boil sol. of acid to drive off sulphurous acid before adding carb. baryta.

1826. JANY. 3.

Flaming salt dried on sand bath and analyzed Decr. 15th: 10 grains by heat and Sul. acid gave 4.16 sul. baryta.

8 grains mixed with per oxide of copper and heated in a tube—sulphurous acid gas evidently came over. On unpacking the tube the oxide almost all reduced—put into N. A. and N. M. Acid all dissolved with exception of a white powder and a minute quantity of charcoal—filtered—the clear solution precipitated by Mur. baryta gave 3.2 sul. baryta. Hence seems to have been S. A. in excess over the baryta in salt unless it came from oxide of copper.

7 grains same salt rubbed with 7 grains pulverised native carb. baryta, then mixed with 349 gr. per oxide of copper and heated in a tube, the gas being passed through a little mixed solution of Mur. baryta and baryta water; the latter immediately became carbonate but the Gas had no smell of suls. acid. After the operation a little N. A. added to washing water rendered all perfectly clear by dissolving the carbonate; hence no suls. or sul. c. acid there. The tube was examined; its contents were considerably reduced—being dissolved in a flask with N. M. Acid some insoluble matter was left; this rubbed in a mortar with fresh N. M. Acid to remove all soluble was put with the rest and a little Mur. baryta added for greater safety. The sulphate of baryta when collected weighed 10.2 grains.

Then 7 grains of the same carb. baryta and 349 of the same per oxide of copper dissolved in the same acid, etc. and treated in the

same way gave 3·5 gr. sul. baryta. This therefore the quantity of S. A. present independant of the salt.

10 grains flaming salt gave alone 4·16 sul. baryta = gr. baryta
 10 grains Do. ox. copper 9·57 „ =

7 grains salt by ox. copper, etc. gave 10·2, which minus 3·5 for accidental S. A., etc. = 6·7 sul. baryta or 10 grains would give 9·57.

Oil gas product not boiling below 200°; 1 vol. with 1½ vols. of Sul. c. acid—mixed and heated till dark coloured and suls. acid came off—on adding water became dark green and there was no separation of oil. The acid saturated with carbonate of potash gave a brown solution which, when concentrated to a certain degree, crystallised especially at the edges in a very peculiar manner. Shining fibrous filaments rising up like asbestos thread and extending from $\frac{1}{8}$ [?] of inch to 1½ inches even. In some cases they resembled a vegetation of moss or mould, and the mass of the solution had crystallised in similar fibres lying in horizontal but curved directions, so that when moved it resembled a mass of cotton fibres. The salt had considerable tendency to vegetate. When evaporated to dryness a brown salt was obtained which heated on foil burnt dully and left a charry sulphate of potash.

A portion of solution of the salt was precipitated by alcohol and filtered. The precipitate pressed and dried, then dissolved in water and crystallised, gave pearly crystals but had evidently lost something. The crystals had retained all the colour.

The alcoholic solution was clear and colourless. When evaporated it gave a portion of combustible matter soluble in water and which added to common sulphate of potash made it *highly pearly*. Can now easily form pearly salts.

1826. J A N Y. 4TH.

The dried brown salt was pulverised and digested in alcohol; a brown solution was obtained which by evaporation yielded a substance solid and apparently crystalline when cold—yellowish brown—soluble in water and in alcohol—highly sapid, being first saline, bitter and cooling and then sweet. It seemed further unchanged by solution and powerfully affected the crystallization of sulphate of potash. Exposed in aqueous solution it gradually

dried, the forms remaining appearing to be crystalline but with difficulty only.

Go on to March 28th for expts. with this substance.

Mur. Potash with this substance—compared with pure *mur. pot.*, not much difference—tendency to dendritical forms, the cubes being grouped in lines passing outwards from the eight solid angles of the cube—was very little substance present.

Nitre with little peculiar substance—no difference between it and the pure solution—with a little more, crystals made up of a number of small ones symetrically arranged—each a hexadral prism. When still more of substance *nitre* became dendritical, the laterals passing off at angles of about 60° . Same phenomena by evaporation of small quantities on glass plates.

Sul. potash changed—pearly, fibrous, etc. as before.

1826. JANY. 5TH.

Tindery salt same as that analysed Decr. 15th.

7 grains with 7 grains carb. baryta and 363 gr. per oxide of copper heated in tube and treated as salt of yesterday gave 10.2 grains *sul. baryta*—or ten grains would have given 14.57 gr. *sul. baryta*.

7 grains carb. baryta and 363 gr. per oxide of copper Do. Do. gave 4.18 grains *sul. baryta*—or ten grains carbonate and proportionate quantity of oxide would have given 5.97 gr. sulphate baryta.

10 grains of same tindery salt by heat and *Sul. acid* gave 4.18 gr. sulphate baryta:

Hence $14.57 - 5.97 = 8.6$ gr. sulphate of baryta, i.e.

10 gr. tindery salt contains *sul. acid* enough to make 8.6 gr. *sul. bary.*
 Do. Do. Do. baryta 4.18 Do.
 or very nearly one half; hence two proportionals of acid and one of base in the salt.

1826. JANY. 6TH.

Repetition of experiment of Jany. 3. Same flaming salt.

7 grains salt, 7 gr. carb. baryta, 312 oxide of copper in tube, etc. as before. Then the contents of the tube digested in a flask with 1 oz. nitric acid, $\frac{1}{2}$ oz. *Mur. acid*—then $\frac{1}{8}$ oz. N. A. and $\frac{1}{8}$ oz. M. A.,

which completed solution, etc.; the sulphate collected as before equalled 9.8 grains—or 10 gr. salt, etc. would have given 14 grains.

7 gr. carb. baryta and 312 gr. oxide of copper dissolved in the same quantity of the same acids and washed in the same quantity of the same water, etc. etc. gave 3.5 gr. of sulphate of baryta. Or 10 gr., etc. would have given 5 grains sulphate.

14 - 5 = 9 gr. sul. baryta.

Hence 10 grains flaming salt contain *Sul. acid* enough to make 9 gr. sul. baryta.

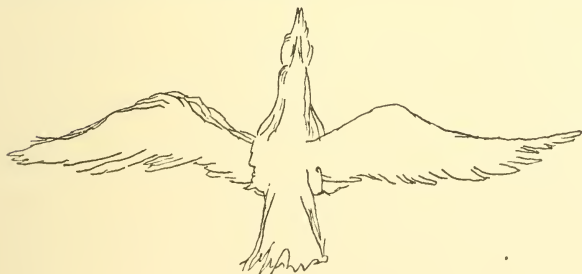
Flaming baryta salt heated in tube gave out sulphurous acid very decidedly. Another portion heated so as to just drive off some of the naphthaline, then the contents digested in a little water, were decidedly acid to litmus paper, though not so much so as I expected, seeing that there are two proportions of *Sul. acid* present—tested by Mur. baryta it gave slight evidences of *Sul. c. acid*; it is however probably suls. acid. Another portion of the salt heated and liberated vapour, gas, etc., passed through solution of acetate of lead—precipitate white at first but at last discolouration produced by a little sulphuretted hydrogen—hence sul. hydrogen liberated. The solution was afterwards treated with N. A., but a considerable portion remained undissolved which appeared to be sulphate of lead.

1826. JAN Y. 18TH.

Measurements and weight of a fine sea gull brought here by George from Mr Harding.

	feet	inches
From tip to tip of wings	4	10
„ beak to tail	2	4
Average width of wings through the 4 ft. 10 i.	0	7½
From tip of tail to setting in of wings		9 inches
Width of tail part near wings, i.e., of body there.	5	„
„ „ extremity moderately extended		9
Each wing, length of	2	3
Thickness of body.		5
Weight of the bird with all its feathers, etc.	3 lb.	4¼ oz.

or 52¼ ounces avoirdupois.



See Back to Jany. 3rd and 4th for substance here worked with.

Different salts were tried as to effect of this substance on their crystalline forms. The salt was dissolved and divided into two portions, one being left unaffected for a point of comparison, the other had a little of the substance dissolved in its solution. The solutions were crystallised in capsules and also on glass plates in drops, and equal strengths, temperatures, etc. were always attended to.

Mur. soda: not much difference in small quantities except a general looseness of aggregation and less perfect forms with *substance*.

Nitrate Soda. Is rendered less readily crystallizable. In the basin it does not make definite and clear rhomboids but forms three or four large masses with general crystalline shapes, but opaque and composed of a number of minute crystals grouped together so that on the whole the large crystals have an apparent granular structure. Films of the substance probably or perhaps a little altered gradually separate from these solutions.

All the solutions of salts containing the substance and also water are particularly prone to the formation of separate spherules on the surface which run about without contact with the fluid beneath.

On glass plate the substance N. of Soda gave numerous dendritical arrangements at right and oblique angles. The pure N. of Soda did not do this but gave more or less perfect rhomboids.

MARCH 30TH, 1826.

Sul. Magnesia—in basins no apparent difference. On glass plates that with *substance* gave most radiated films, crystals smallest and most confused.

Sul. copper. Alone blue colour—in basin separate crystals very definite and clean—on glass plate the same. *With substance*—solution of green colour—in basin vegetated crystals all on the sides and pearly and indefinite—colour of crystals light green—loss of colour due in part to division or want of compactness. On glass plate crystallised in radiated portions—forms imperfect and not at all like the pure salt—colour pale green. A very little of the

substance affects the salt and causes vegetation with pale green and pearly crystals.

Oxalic acid—not affected by the substance.

Alum—interfered with a little, not much—crystals are smaller than when substance is not present—observed best on glass plate—not much difference in capsule.

Rochelle salt—on plate very little interference—in capsules very little interference except that forms of crystals seemed to approximate to right angled parallelopipedons.

Sulphate of Nickel—no interference.

1826. MARCH 21ST.

Liquor from pipes of oil gas apparatus at Apothecaries' hall—rectified—given me by Mr Hennel—and Strong Sul. acid—equal weights mixed—great heat—blackening and thickening—much sulphurous acid—put into a bottle and left till

March 29th. When the little separate black acid below which was fluid was poured off and separated from very thick, almost solid black mass above. The two were then treated separately.

The acid diluted much—heated—filtered—again heated to drive off sulphurous acid—then rubbed with marble powder till neutral, diffused through much water, the clear solution filtered and evaporated; as it concentrated it assumed a brown tint from mere approximation of parts but did not taste of substance; when equal to about half a pint it was filtered to separate sulphate of lime—evaporation continued until becoming stiffer, then alcohol added and thus a solution obtained by filtration a little of which added to sulphate of potash or sulphate of copper gave peculiar crystals—much lime remained in solution as a soluble salt and substance was dark coloured, but being evaporated, dissolved in water and boiled with animal charcoal the colour was exceedingly diminished. The solution retained all its peculiar properties and still held much lime as a neutral soluble salt. It was bitter and burnt when dry with difficulty, leaving much sulphate of lime.

1826. MARCH 29TH.

The thick pitchy part was added to water and readily diffused through it—it was perfectly black and nothing of consequence

separated by mere rest—heat in a wedgewood basin caused deposition of much heavy pitchy matter at the bottom which was separated and set aside.

The dark acid solution rubbed with marble powder—filtered—was deep coloured—boiled with animal charcoal became very light coloured. Evaporated—filtered to remove sul. lime which separated in crystals at the bottom of the basin. The solution had great power of altering form of sulphate potash and sul. copper and resembled that from *the acid part*. With alcohol it gave a slight precipitate—then filtering and evaporating a fawn coloured salt of lime was obtained which was soluble—when heated, blackened, burnt with flame and left sulphate of lime. The salt became moist or rather damp by exposure to air but did not deliquesce—a very small quantity gave pearly crystals with sulphate of potash.

1826. MARCH 30TH.

Substance of *Jany. 3rd.*

Substance somewhat impure. Is moderately soluble in hot *Ether* but on cooling deposited to a great extent. If much be present it seems to cause the separation of the water or alcohol in the ether in a lower denser separate stratum.

Very slightly if at all soluble in *Oil of turpentine*—fuzes beneath it into a yellow liquid.

Very soluble in *Alcohol*.

Very soluble in *Pyroligneous ether*.

Not soluble in *olive oil*.

Very soluble in *water*.

By heat fuzes, blackens, burns with dense flame and leaves a bulky black residuum, alkaline and containing sulphuret potash. Re-solution in water and in alcohol does not leave the salt or purify the substance from this alkali, it being in such state of combination as to be similarly soluble.

Decomposed in a tube by heat, no signs of ammonia.

With S. A. no action whilst cold—gradual solution on heating it—then charring.

With N. A. cold, mere solution, no other action—heated, decomposition—evaporated, residual matter yellow, bitter and nauseous.

With M. A.—no particular action.

Substance with ether—boiled—when cold, clear solution poured off—evaporated, left a peculiar matter—readily decomposing by heat and charring, burning with flame leaving sulphuret potash—hence not free from salt. Residuum boiled again with ether—solution on cooling deposited crystals—boiled a third time—the two ether solutions evaporated together—gave similar results to former ether solution.

1826. APRIL 12TH.

The residuum was a soft brown solid matter—boiled with more ether gave a solution which when cold deposited the filmy crystals—these collected—they burnt, blackening, fusing and causing flame and left an alkaline residuum—they were not deliquescent and had same taste as substance altogether.

The residuum acted on by more ether—by ether and alcohol mixed and in various ways hot and cold to get separation, but all the results seemed of the same kind—they all contained potash in abundance when burnt and no substance free from potash and giving peculiar crystals could be obtained. Suspect that the substance is essentially a salt or an acid, since there can be but a very minute quantity of anything not a salt present in the matter.

Substance heated and agitated with Hennel's purified oil gas liquor—no apparent solution—the whole warmed, began to brown—shaken and stirred—residuum became more solid instead of less so—the oily fluid deep brown—added to water, heated, well shaken, filtered through a wet filter and the aqueous solution evaporated, but it gave nothing—cannot separate substance this way.

Substance: 2 gr. of it and 200 sul. potash dissolved and crystallised gave ordinary crystals—added 2 gr. of substance (x) of April 16th, redissolved and crystallised—gave pearly crystals—100 gr. more of ordinary sulphate added—redissolved and crystallized gave slightly pearly crystals.

Have been heating some sulphur in a flask to sublime it. Having left it on sand bath flask has broke and sulphur run out, but part has sublimed in the flask and on that part of the flask, but a little way above the sand (when examined cold next morning) there were found portions of sulphur in drops. Many of these were solid, opaque and yellow but many were in clear, transparent, yellow, fluid drops, though quite cold, and these were pure sulphur. If rubbed with the finger they spread like oil but instantly became solid—feeling sticky at the moment of fluidity—if touched with a solid body they instantly became solid and almost at the same moment opaque and yet if not touched by a solid body they remained fluid and transparent for a long time. Query the mechanical arrangement of the particles in the two states. The case resembles that of water cooled below its freezing point, etc.

Some globules have remained unsolidified to this day—May 15th.

1826. APRIL 16.

See March 21st, 29th.

All the solution of the salt of lime and soluble substance affecting the appearance of the sulphates obtained as described in these pages¹ was evaporated to dryness and a fawn coloured salt obtained—was soft—damp—of a bitterish taste—burning when heated into sulphate of lime—and powerfully affecting the crystals of sulphate of potash and sulphate of copper. It may be distinguished as (*x*).

3 grains of (*x*) + 300 gr. sul. copper—dissolved and crystallized gave pearly crystals—added 100 more sul. copper—pearly crystals—100 more sul. copper—pearly crystals but large like those given to M. Levy—100 more sul. copper, still pearly—100 more sul. copper—still pearly but now approximating to common appearance—100 gr. more sul. copper—still slight traces of pearly flakes on one side of the crystals—but not far from common crystals—these contained 3 gr. of (*x*) and 800 gr. sul. copper.

A portion of (*x*) digested in ether—clear solution evaporated gave a dry substance which burnt with more flame than salt

¹ i.e. under March 21st, 29th on p. 293.

altogether but contained abundance of lime. It was dissolved in water and also a portion of (x) dissolved in water without being previously acted on by ether—both solutions being evaporated, that by ether left matter having very little colour and was much the purest—both gave dry masses but that by ether fused most perfectly and burnt with most flame on platina foil; it also left smallest and hardest residue. The dry portions exposed to air for 12 hours did not deliquesce or moisten and seemed to have undergone a little change by evaporation to dryness.

Equal portions of each were added to equal portions of sulphate of potash and dissolved; then crystallized—the crystals were both pearly but it required much more apparently than usual to produce the effect, I suspect from having been too far evaporated at first.

1826. APRIL 18.

A portion of (x) dissolved in water—equal volumes of the solution put into separate basins, *one* evaporated to *dryness*, then dissolved in the basin—the other not so heated. Equal weights of sulphate of potash with water added to the two portions and dissolved so as to yield crystals on cooling—when cold next day both had yielded pearly crystals and equal in appearance. Hence evaporation to dryness *does not* seem to injure the peculiar substance as was at first supposed.

A portion of (x) put into a retort and distilled with water; the water or product condensed added to sulphate of potash gave

1826. MAY 3.

A portion of (x) precipitated by excess of oxalic acid and filtered to separate the oxalate of lime—the evaporated liquor became brown and on cooling, solid (ϕ)—added to sulphate of potash it still made it pearly—heated on platina foil the oxalic acid was dissipated and ultimately the substance blackened and burnt with flame and by blow pipe left a white ash which was sulphate of lime—hence not freed from lime by oxalic acid. Another portion of (ϕ) was heated in ether, shaken and left to cool; the ethereal solution was poured off from the liquid below—by evaporation it left a liquid which when cold was solid and on solution in water shewed but little oxalic acid by mur. lime—a second portion of

ether on the residuum when separated gave but little substance—the tube with unacted portion or residuum, when dissolved in water and tested by mur. lime, gave plenty of oxalic acid—hence a partial purification had in this way been effected.

1826. MAY 16TH.

Pearly sul. copper dissolved in water and crystallised—the crystals were as pearly as at first.

A large quantity of pearly crystals dissolved in water and crystallised; it gave pearly crystals. These separated from the mother liquor and dried on bibulous paper, then a second time dissolved in water and crystallised, gave pearly crystals—the crystals separated and dissolved a third time; crystals obtained still apparently as pearly as before—dissolved a fourth time, pearly as ever—dissolved a fifth time, still pearly—a sixth time, pearly—a seventh time, pearly—eighth time, still as pearly as ever and now as quantity left was small finished the experiment.

An aqueous solution of clean crystals of pearly sul. copper poured into alcohol, the precipitated sulphate separated by a filter from the solution—the solution contained but very minute trace of copper or sulphate and by evaporation gave a little substance which, when heated, burnt and left trace of oxide of copper, and added to common sulphate of copper rendered it pearly. On the contrary the precipitated sulphate of copper being washed with alcohol was after solution in water crystallised and gave *ordinary crystals*.

A portion of (x) dissolved and solution of carbonate of ammonia added to it in excess—filtered and found to retain no lime—evaporated on sand bath and left there for 2 or 3 weeks that the excess of carb. ammonia might be dissipated. Now dissolved and filtered—tested by Mur. lime no precipitate—hence no carb. ammonia left—is now peculiar salt of ammonia (↔) and of a dark brown colour.

A very little of the solution crystallizes sulphate of potash strongly pearly. Evaporated to dryness carefully, became a shining brittle brown mass—very sapid and bitter—burning with much flame and aromatic odour—leaving charry and ultimately a white film—very small in quantity—is very deliquescent.

3 grains of (◇) and 300 gr. sul. copper gave pearly crystals—300 more sul. copper, still pearly—a third 300 sul. copper—pearly—a fourth 300 sul. copper—solid forms, but had pearly lustre in one direction. Here only 1 of substance to 400 of salt.

A portion of (◇) boiled with caustic baryta in excess—ammonia came off—put into a basin and evaporated to dissipate all the ammonia but by accident was carried too far and even charred slightly—on dissolving in water, agitating with carbonic acid gas to separate excess of baryta and filtering, a brown solution of a barytic salt was obtained—neutral—by evaporating yielding a dry salt burning with flame and leaving charry residuum. It resembled a sulphonaphthalate in appearance—but heated in a tube no naphthaline rose from it, but an oily fluid burning with flame; it was soluble in water and Alcohol, etc.; added to Sul. copper, Sul. baryta precipitated—filtered and crystallised, the sul. copper was not pearly but took a granulated and earthy form, and by stirring became a soft solid—it resembled some of the sulphonaphthalates in appearance—added more sulphate of copper, redissolved and set it aside to crystallize—next morning highly pearly crystals in large flakes—had at first been too much of the substance.

A portion of (◇) evaporated to dryness—digested and boiled in ether—the ether solution poured off and evaporated left a little of bitter matter which with sul. copper gave earthy pulverulent vegetation—no pearly crystals—added much more sul. copper and redissolved; now gave a soft and pearly mass but not distinctly crystalline—added more sul. copper and now obtained a pearly salt. Think that there must be less peculiar matter here than in any other experiment.

1826. SEPT. 13TH.

Experiments on vaporization—to be set aside for a year or two. Bottles stoppered, well cleaned and dried, the solutions put into the bottles so as not to soil the sides and the solid substances put into clean dry tubes which, being carefully wiped outside, were then let down into the bottles, the stopper put into its place and tied over with bladder, and then the whole carefully set aside

without agitation. The bottles were numbered by a diamond and their contents as follows:

<i>bottle.</i>	<i>contents of tube.</i>	<i>Sols. in bottle all very clear.</i>	
I.	Crystd. Mur. baryta	Sul. soda with drop of N. Acid	These were put on Tuesday, Sept. 12, 1826.
II.	Fuzed Chloride Sodium	Nit. silver	
III.	Crystals of oxalic acid	Mur. lime	
IV.	Crystd. common salt	Mixture half S. A. half water	
V.	Oxalate ammonia	Mur. lime	
VI.	White arsenic	little sol. potash	
VII.		Some of the S. A. used in these expts.	
VIII.	Mur. ammonia	Mixture half S. A. half water	
IX.	Ferro pruss. pot.	Per sul. Iron	
X.	Calomel	little sol. potash	
XI.	Corrosive sublimate	little sol. potash	
XII.	Chloride of lead	Chromate of potash	These were put on Thursday, Sept. 14, 1826.
XIII.	Nitrate lead	Chromate of potash	
XIV.	Chloride of lead	Iodide of potash	
XV.	Carb. Soda	Mur. lime	
XVI.	Nitrate ammonia	Dilute Sul. acid	
XVII.	Ferro pruss. potash	Sul. copper	
XVIII.	Iodide of potash	Acetate of lead	

All tied over with bladder and carefully put bye.

See Sept. 25, 1827 and Oct. 29, 1829.

1826. SEPT. 15TH.

Have to day examined some experiments on the escape of oxygen and hydrogen (mixed) from over mercury. They were commenced June 28th, 1825 and the note relative to them in the Laboratory book is as follows: "1825 June 28—About 2 vols. hydrogen and 1 vol. oxygen mixed in jar over mercury—fused chloride of calcium introduced to remove water—3 stoppered bottles well cleaned and dried and nearly filled with the mixture, the stoppers put in and the bottles set aside (sealed up) in glasses containing mercury."

At this time, Sept. 15, 1826, after a lapse of 15 months, the experiments were examined. The cupboard was found sealed up, the seals unbroken—the string being cut the bottles in their glasses were found undisturbed. One of them was brought away,

opened over the mercurial trough, a portion of the gas transferred to a tube and examined by a taper; it did not explode but supported the combustion exactly as common air would do and was indeed nothing but common air. The stopper was replaced and the bottle with the rest of the gas returned to the cupboard and sealed up with the rest, and I think that in all of them the level of the mercury within the bottle was higher than that outside in the glass confining it. Thus the former results are abundantly confirmed. See June 26th, 1823.

1826. SEPT. 16TH.

Have examined the other two bottles of gas; found both of them to contain explosive mixtures—transferred portions therefore to tube and introduced spongy platina to remove the oxy hydrogen—warmed the tubes to expediate the action—about two fifths of the air of one bottle and rather more than one half of the air of the other disappeared; hence such were the proportions of the mixture left. The residue supported the combustion of a taper a little more brightly than common air.

1827. SEPT. 21.

A clean newly varnished trough and mercury cleaned during the summer by Sulphuric acid. Hydrogen made over it into cylindrical jars and the gas dried for three hours by pieces of chloride calcium. I have had some small flat gas jars made for these experiments about 2 inches in the mouth one way and the half or the third of an inch the other: the height about $1\frac{1}{2}$ or 2 inches so that they had little capacity for gas but great contact with the mercury. Portions of the hydrogen were put into four of these vessels; these were then put into a Wedgewood's basin together so as to stand in the mercury about half inch deep, the mercury inside being much higher, perhaps $1\frac{1}{2}$ inches. The height of gas in all was carefully marked by slips of paper stuck on at *apparent* place of contact of mercury with glass. All four covered over with a stoppered jar standing also in the mercury, and then moderately good oxygen thrown into this jar by a bladder and tube so as to form an atmosphere of oxygen outside the four



small jars. A piece of chloride of lime put into the oxygen to keep it dry. All put by in a dark place.

SEPT. 27.

The above experiment examined. A little gas transferred from one of the vessels by a Pepys transferrer and the electrical spark passed through it in a Eudiometer—no appearance of explosion. The vessel and remaining gas returned to the basin and again covered with an atmosphere of oxygen and put by as before.

There had been no sinking of the mercury below the marks.

Novr. 1. Examined—no sinking of gas—no detonation—jars returned and oxygen put over.

SEPT. 25TH.

The experiments of Sept. 13, 1826 examined.

- I. No change except that Mur. of Baryta is wet.
- II. The chloride of sodium is covered an inch deep with solution; the nitrate of silver unchanged except by concentration.
- III. No apparent change.
- IV. Do.
- V. Do.
- VI. The arsenic slightly yellow—probably so at first. The potash solution slightly fawn coloured.
- VII. As at first.
- VIII. No apparent change.
- IX. No change except that ferro prussiate is wet, as XVII.
- X. No apparent change.
- XI. Do.
- XII. Chloride of lead not changed in appearance. The chromate turbid as in XIII.
- XIII. Nit. of lead not apparently changed. Chromate of potash is slightly turbid; perhaps has acted upon the glass.
- XIV. No apparent change.
- XV. Carb. soda wet—part in solution; Mur. lime a little mouldy but no precipitate—apparently no change.
- XVI. Unchanged in appearance except that N. Am. has acquired water, is partly moist and has crystallised on the glass

in consequence—water has passed over here and elsewhere in vapour but in no case by capillary attraction up sides.

XVII. No change except that ferro prussiate potash is wet at bottom of the tube—saturated solution there about half inch.

XVIII. Iodide of potash contains a black precipitate—the acetate of lead is dry and has crystallized—there is a blackish film in small quantity on surface of iodide in tube. The iodide of potash is of a full orange colour.

No apparent change in any of them by vaporization of any thing except water and perhaps in the last of a little acetic acid. Again put bye as before.

See Oct. 29, 1829.

1827. SEPT 25th TUESDAY.

This Evening a magnificent *Aurora borealis* occurred. It began I understand about 10 or a quarter past 10 o'clk. and continued until 2 o'clk. next Morning. I saw it from about 11 o'clk. to half past 12 o'clk. At 11 o'clk. it was like a powerful clear twilight or a break of morning from behind a low ridge of dark picturesque clouds towards the north, but the effect extending from North West to East north east and 40 or 50 degrees in height. There was also much fine red coloured light in the westerly part. The sky was otherwise clear, the wind from the south west and but slight in power. Gradually the light changed in appearance, the red colour in the west extended towards the north and then passed away; the light towards the north varied in intensity, large portions diminishing in brilliancy, others increasing, and after a while a fine broad pillar of red light gradually formed about ENE which rose obliquely upwards to the height of 30 or 40 degrees, pointing to a part a little south of the Zenith. After innumerable changes in the light towards the horizon both as to colour and intensity the whole gradually assumed the appearance of faint columns or rays, all converging to a spot a little south of Zenith, and about $\frac{1}{2}$ past 11 or $\frac{1}{4}$ to 12 dancing or flashing was perceived. It appeared as if part of the sky towards the zenith suddenly glowed with a phosphorescent pale light which then decreased, to be renewed in other parts, and after a short time the light appeared to be progressive upwards from the red column to the



west especially, and also from the other parts. It was more like the effect of a communicated impulse to parts of the space or sky contiguous to each other than a flash upwards, and it was always pale white. The blushes were very rapid about the zenith. The direction of the columns and also of the flashes was always to a part south of the zenith, and we soon perceived that light blushes were rising to the same place, not from the west, north and east only but also from the south, commencing not from the horizon but perhaps the height of 50° or 60° . Even upon the horizon at last light was streaming upwards from the south of East and ultimately at least two thirds of the visible hemisphere was in the flashing or blushing state. A remarkable fact relative to the lines of direction toward the one spot south of Zenith was that, even when the blush did not proceed along them, but across them or simultaneously over a large space, still they were visible and apparently as fixed in their position as ever. It seemed as if there were a *permanent set of invisible* rays or columns all pointing to the particular spot south of the Zenith which were rendered partially and transiently luminous by patches at a time. The appearance may be understood by supposing a hemisphere painted in stripes with transparent colours, and light flashing upon it momentarily in different places so as to render the stripes partially visible, the light expanding at times across the direction of the stripes.

Another effect observed was an intense glow of light to the west of north which gradually rose and crept up towards the zenith in a very slow manner; it faded away before it rose 60° but was very bright up to 45° or 50° ; as it rose it left the part beneath comparatively dark; it continued perhaps 5 minutes on the whole.

The stars were visible through the aurora but always appeared slightly dimmed when the light flashed over them, as if obscured slightly or as if the new light, forming less of a contrast than the previous darkness, made them less conspicuous. I left the phenomena in full vigour at $\frac{1}{2}$ past 12 o'clock.

A beautiful areal phenomenon observed about St. Paul's Church, from the shadow of the dome and the part above cast on very thin clouds moving at that height. The moon at the full and rising. On looking at St. Paul's cross from Ludgate hill, about stationers' Court and the opposite side a stream of darkness seemed to issue from the part above the dome, and expanding seemed to pass over the head of the spectator; by moving a little to the north or south so as to get under the edge of the shadow it was exceedingly well defined and distinct. Each of the turrets in front threw a similar shadow, but more faintly. As the moon rose and moved towards the south the shadows or rays also changed their directions, and at last they were best seen from the corner of Ludgate hill and St. Paul's Church Yard. The mist or cloud was very faint, for the stars could be well seen. Whilst looking at it my companion thought she saw a black ray in another direction; this however proved to be the clear space between one thin cloud and another, and watching this and by it tracing the motion of the cloud in the wind, we were able to account for the increase and diminution in strength of the shadow of the church spire as the cloud came up and afterwards passed over. The effect was very beautiful. Many persons went away fully convinced that rays of darkness were issuing from the Church. Time about 8 o'clock.

1827. SEPT. 29TH.

The products from distillation of bone oil (Octr. 29, 1825) resumed and examined.

The first product (as formerly marked), i.e. the first portion of Naphtha, was ammoniacal—agitated and washed several times with water—still faintly ammoniacal—then washed with very dilute M. A.—this removed ammoniacal odour but left the peculiar penetrating odour of burnt animal substance and the colour of specimen became darker than before.

The *washed substance* or product—very fluid—combustible with bright flame like naphtha—being heated in a closed tube so as to decompose part of the vapour and deposit carbon a *little ammonia* was evolved—upon adding hydrated potash and heating much more ammonia formed.

Some of the *washed fluid* to sol. carb. potash—no particular effect.

Do. to its vol. of strong solution muriatic acid pure—fumes in the vacant space of the bottle as if ammonia present or some such thing—heat evolved considerable and continued for some time—but no gas or volatile vapour escaped—shaken well together and left to stand—separated and examined—acid very dark and increased in quantity, substance dark also and diminished in quantity; it was still very fluid; more M. A. was added and shaken with it, but there was no more sudden action or heat; they were however left to separate.

The acid already spoken of was deep coloured—rather thick—had an aromatic odour resembling a little that of the washed bone oil. A little water being added no oil separated but only a few clammy flocculi—the acid either strong or diluted not combustible on paper. After dilution it was filtered; a clear acid brown fluid was obtained, not changed by boiling, which when evaporated to dryness left a brown shining varnish in the basin, not deliquescent in the air. It was slightly acid and bitter to the taste and when heated in a tube gave animal smell, but no free ammonia to turmeric—there was a little free acid and probably muriate of ammonia.

This brown shining substance when put into water partly dissolved, and left films which were not soluble in alcohol, ether, water or ammonia and very little affected by Muriatic acid—when heated they burnt and left a carbonaceous residue; they were of an animo-bituminous nature.

Excess of ammonia was added to another portion of the filtered acid solution—a flocculent precipitate—boiling caused more facil separation—substance fawn coloured—solution clear—this substance when separated rendered dark coloured by M. A., but not quite soluble in it, and appeared to have the same qualities as the scales or thin plates of shining substance obtained by evaporation.

OCTR. 5, 1827.

Another portion of the filtered brown fluid left several days exposed to the air became much deeper in colour and now communicated a reddish brown stain of considerable intensity to the skin, paper, etc. The residuum and other portions have also

darkened much in colour. The acid fluid also now simply a tar smell, not peculiar smell.

The *product* separated from the second portion of acid was somewhat diminished in quantity. Being treated with a third and fourth portions of acid it was almost entirely changed. The acid as they were separated had properties generally resembling those of the acid already described, but the substance separated by the ammonia was of a paler buff colour.

The *second product* obtained by distillation examined—was ammoniacal as first, etc.—being washed with water and then with acid underwent similar changes—washed portion gave ammonia when decomposed by heat, especially when potash present. With sol. carb. potash no apparent change. By M. A. changes similar to former but not so much heat evolved—the only difference in appearance is that substance is not so readily acted upon by the acids.

Further examination of the *first product*. Alcohol dissolves it—water throws it down—ether dissolves it. Pyroligneous ether dissolves it.

A portion with strong S. A.—do not act suddenly—the S. A. darkens a little—by no means so suddenly as oil gas products and the portion of incombustible fluid undissolved does not seem deepened in colour but rather lightened. Much S. A. appears to dissolve all the fluid—water partially separates it again.

A portion with nitric acid acts but little—no heat—acid deepens a little in colour—the fluid portion scarcely at all—water causes the Nitric acid to become yellow.

A portion with strong acetic acid—but little action—acid dissolved a small quantity of substance which was thrown down by ammonia.

There were six products of the bone oil (Oct. 29, 1825); the first smallest in quantity—the rest about equal—all contain ammonia.

I. Naphtha like—very combustible—bright flame.

II. Very combustible—denser apparently than first—not so fluid or ethereal in appearance—transparent—no crystals or sediment.

III. Rather clearer in colour than II; perfectly transparent.

IV. More dense—deeper in colour—greenish by reflected light—there are crystals apparently deposited on the sides of the bottle and a muddy crystalline mixture at the bottom.

V. Far more ammoniacal than IV or III—colour also browner and substance more tarry—there is a little water at bottom and sides of the bottle—fluid is fouled by a sediment, small in quantity. Something has been decomposed during the distillation about the time this came over.

VI. Very ammoniacal but also something of the ethereal or spiritual odour of the first product—is thick and tarry—deep coloured—reddish—but has not produced the stain on the side that V has deposited nor the crystals of IV.

The Six products put into equal small tubes (No I has however been washed with water once or twice).

III. Lightest colour—II very little darker—I considerably darker—IV darker than I—V and VI so dark as hardly to let daylight pass through, though the tubes only three tenths of an inch in diameter—VI the darkest—these two products V and VI poured very thick like oil.

The tubes put into a mixture of ice and water.

I slightly turbid, very fluid—II quite clear, not quite so fluid as before—III quite clear, much thickened—IV quite clear, but will scarcely run in the tube, is so thick—V apparently lighter in colour but thicker than IV—VI very dark coloured but clear, very much thickened.

Now put into a mixture at 0° F.

I a few crystals round the top, rest quite fluid—the crystals appear to be water only—II quite clear and fluid, unchanged nearly—III a thick mixed mass of much fluid and apparently of very fine acicular crystals—IV a soft solid—V a harder solid—VI harder still—and none of these three shewed appearances of crystallization.

OCTR. 17TH.

Bone oil products: No. 3—agitated with water—latter separated—filtered—nearly clear—evaporated—left a brown moist thick sub-

stance—soluble in water and apparently not altered by re-evaporation—bitter to taste. When heated in capsule water rose first, then white acrid vapours of substance—and ultimately a charry stain left. The vapours when ignited burnt with white flame. The substance is soluble in alcohol, ether, pyroligneous ether—in first spirit from bone oil—slightly soluble in oil of almond—not soluble in essential oil of laurel. Its aqueous solution alkaline to turmeric paper, and also to redenned litmus paper, from ammonia present—M. A. causes no precipitate but darkens the colour slightly. Potash causes no apparent change.

1827. N O V R. 17TH.

Bone oil products. The 3rd and 5th have been washed several times and the washings evaporated. They have much less of any thing than the washings of first product and the matter does not seem interesting. It is tarry, oily, etc.—partially resolvable in water and becomes dark coloured by exposure to air.

The washed *No. 5 product* not ammoniacal at first—but became so by being heated in a tube to redness; there is some compound of nitrogen present. The washed *No. 5 product* heated with sulphur was immediately decomposed—carbon deposited and ammonia with excess of sulphuretted hydrogen evolved.

NOVR. 19.

Three tubes charged with N. M. Acid and sealed up hermetically.

Tube I. 1 vol strong N. A. and 1 vol. strong M. A.

II 1 Do. 2 Do.

III 1 Do. 3 Do.

these put on the sil of the window exposed to light.

1828. F E B. 26.

Conceived that when a bar of soft steel was converted into a magnet, the particles if they become each magnetic independant of the others ought to exert such power of attraction upon each other as to influence the density of the bar, for upon the received theory their attraction ought to be super added to the attraction of aggregation in the *direction of the axis* of the magnet. To try

whether any sensible effect is really produced, a soft steel bar 11 or 12 inches long was put into a wedgewood pyrometer indicating the expansion or contraction by levers which multiplied the effect 400 times; but on holding powerful magnets to it, or converting the bar into a magnet, no change in length either one way or the other could be observed.

APRIL 22ND.

Made a ring of clean copper wire, soldering the extremities; fixed it with thread to a piece of wire and suspended it as a balance of torsion (as in fig.); introduced the pole of a strong bar magnet through the ring, supposing it might exert an influence upon it; but upon bringing other magnets near the wire could observe no effect, whatever the position of them.



Brought the middle and other parts of a horse shoe magnet round the wire connecting the poles, but this closed circuit produced no effect.

Repeated the experiments with a copper ring not soldered but twisted together at the ends, but obtained no useful results. Repeated them also with a ring composed of many alternations of platina and silver but still obtained no direct results.

SEPT. 19TH, 1828.

As to Solubility of Corr. Sub. by Camphor in Alcohol. Put camphor into a tube and added Corr. sub. in powder—upon applying heat to melt the camphor the Corr. Sub. readily dissolved, and on cooling the whole crystallized together—in stars, etc. very different to either Camphor or Corr. sub. alone. The two bodies evidently unite to form a compound which is crystallizable.

When heat is continued or raised—action takes place, the mixture becomes brown and ultimately black. Calomel is deposited, being insoluble—and also a portion of charcoal which causes the colour. Mur. acid is evolved—and a fluid substance, apparently a compound of Chlorine, carbon and hydrogen is formed and rises at the same time with camphor. The degree of change, the time required and the quantities of substance formed vary with the proportions mixed. The formation of the

calomel and carbon was ascertained by separating them and examining their properties.

If about equal parts of Camphor and Corr. Sub. be mixed it requires long continued digestion before all the Corr. Sub. is decomposed and the carbonaceous part is not at once separated; but a dark coloured substance is formed which, containing camphor in abundance, is sol. in Alcohol but not in water.

If little camphor and much Corr. Sub. be used the blackening is more quick and decisive. Much M. A. Gas comes off, water is formed and a limpid fluid rises which, though containing much camphor, is not solid unless cooled to common temperatures. This fluid does not dissolve in water—dissolves in alcohol, burns with bright smoky flame and evolution of M. A. Gas and taste[s] acrid like a chloro carburetted hydrogen. Per se it distils unchanged—but by more Corr. Sub. is apparently entirely decomposed, evolving charcoal and M. A. Gas as before. I am not quite sure that no chloride of carbon is formed.

This clear fluid is the only thing worth attention. It may deserve looking at as a *triple hydro chloride of carbon*. Probably obtained by distilling camphor through plenty of Corr. Sub.

Camphor and Calomel have no action on each other.

SEPT. 22ND.

If a little alcohol be put into a tube, then 4 or 5 times its weight of camphor be added, by heat the whole will become fluid, but readily solidifies as the temperature falls. If Corr. Sub. be added in excess and then heat applied the temperature now does not rise so high as to cause any reaction or charring, and a large quantity of the Corr. Sub. is taken up. Then allowing the solution to cool, it may be sunk to common temperature without its solidifying, so that the addition of more solid matter (corr. sub.) has actually much increased fluidity of the mass. This indicates a degree of combination between Camphor and corr. Sub. and the formation of a substance more soluble in alcohol than either of them.

The liquid being poured out on to glass plates soon became solid by evaporation of alcohol, forming white crusts; these smelled of camphor; they were left for some days exposed to air to lose all the camphor that could evaporate—some drips of

alcohol camphor being put by the side of them to indicate when the whole had evaporated.

Sept. 26. No smell of Camphor remained—a little of the substance heated in a tube slightly blackened, but was principally sublimed unaltered. It was in fact corr. sub. very nearly free from camphor, so that it cannot be supposed that any very distinct or definite compound of Corr. Sub. and Camphor had been formed.

SEPT. 23RD.

Heated Naphthaline and Corr. Sub. together—slow action—the impure part seemed to be first decomposed; the Naphthaline rose over and over again, very pure apparently—perhaps a good way to cleanse that substance. By degrees Calomel, Charcoal and M. A. Gas were evolved—but no interesting appearances took place.

Naphthaline does not seem to have much power of dissolving Corrosive sublimate.

SEPT. 26TH.

Heated pulverised Arsenic and ferro pruss. pot. together to see if anything like sul. cyanate of potassium would be formed—but the arsenic sublimed and no appearance of combination took place.

Decomposed a mass of sun light into a coloured spectrum by the prism; threw the ends of the spectrum on to the ends of copper plate connected with the Galvanometer, but could not perceive any effect on the needle; the plates were sometimes in the air, sometimes in dilute sul. acid, sometimes in contact and sometimes a single plate receiving the whole of the spectrum was used and its ends connected with the galvanometer; but no effects were obtained. The experiments were made in a very rough way.

NOV. 1828.

W. Lloyd Caldecot Esqr., 3 Paragon Buildings, has put into my hands some Specimens of true Barbadoes tar—he is through his wife the Proprietor of the Tar Springs. There were 3 small bottles, No. 1, the best, from a spring which gives "*Pottery*"

tar—No. 2, the next best, from a spring called “*Moses*”—No. 3, “*Common*” Barbadoes tar rising from several springs. He also sent me a quart bottle containing a mixture of “*Pottery*” and “*Moses*”. Likewise a piece of the rock strongly impregnated with bitumen.

The two best are supposed to possess powerful medicinal virtues and the object was to discover if possible any peculiar principle which might confer these virtues upon the tar.

The following expts. were made, principally with the mixture of *Pottery* and *Moses* in the large bottle.

The tar has a greenish reflexion of light added to the general brown colour of the substance, and differs in that from the 3rd kind and much more from common tar. Cold Alcohol put on it and stirred at times for many days became opalescent and pale greenish and remained so—water added precipitated a white substance, small in quantity and not resolvable by potash—nor by M. A., but the latter appeared to hasten its separation and deposition. The Alcoholic solution had peculiar smell of Barbadoes tar and also peculiar aromatic taste. By evaporation it left globules having the consistence and nearly the colour of the original tar, not quite so dark; and all the other appearances. Alcohol dissolves very little of the tar and separates nothing peculiar.

Some of the tar distilled per se in a glass retort—products received in four portions; about $\frac{1}{5}$ left in retort—high temp. required—even first product had empyreumatic smell as if decomposition had happened—2, 3, and 4 still stronger symptoms—first pale yellow, others darker, to the 4th—probably in part by sprinkling up in retort—about 3rd product some gas seemed to come over—little water with first but not afterwards—*probably no oxygen in the tar or at least very little*. All the products were neutral to litmus and turmeric paper—*no nitrogen and further confirmation of no oxygen*.

1st product not so fluid as Naphtha—2 somewhat thicker—3 certainly thicker still—4 *thinner* than these, more like 1—*seems as if some solid matter came over before decomposition began*. All the products burn brightly, perhaps last most carbonaceous. Greenish appearance at surface of 2—stronger in 3—strongest in 4.

In alcohol all these products soluble to slight extent only—are

precipitated by water and potash does not dissolve them and even precipitates alcoholic solution—2 seems most soluble in Alcohol.

The residuum in the retort was black and soft like thick tar—not hard like pitch—being redistilled and urged further a fifth fluid product was obtained and left a thick matter becoming quite solid and brittle when cold. This fifth product as thin as any of the former—by standing a few days, 3, 4 and 5 seemed to deposit flaky matter, like oil which has been long heated.

The five products being put into tubes were immersed in ice and water and afterwards in ice and salt to 0° F; 1 scarcely thickened any thing—2 did a little—3 much more—4 more still and 5 seemed a soft solid. None of them gave evidences of crystallization. *The progression was regular when COLD, although not so at common temperatures, for then 3 was thickest. Query something in the 3rd.*

Weak acids appear to have little or no action on the Barbadoes tar—they do not separate any thing interesting.

Alkaline solutions do not appear to dissolve any thing—but they have the curious effect of making the tar much more miscible with water. The cohesion of the tar seems destroyed—hence they may be useful in causing the division (as it were) of the tar for the purpose of bringing other bodies into contact with it, though they do not separate any thing from it.

The Barbadoes tar was distilled with water; after a time a little product was obtained and but very little. It smelt like the Barbadoes tar; there appeared to be no decomposition of the substance. It was less coloured than the tar but had the same general physical properties. It resembled what will be described under the action of ether. By adding alkali and then distilling, no change appeared to occur except that substance perhaps rose quicker—but contents of retort boiled over so much and readily that no precise results were obtained. They did not seem worth pursuing.

Pyroligneous ether has very little solvent power over Barbadoes tar. It separates no particular product.

Ether dissolves Barbadoes tar *entirely*. Alcohol precipitates nearly the whole. Ether with a little acetic acid was used, then

alcohol added, afterwards water—acid came out as it went in—no neutralizing power—in the tar no particular effects.

Some of the tar was dissolved in Ether—alcohol added about its bulk, much precipitated, black—the solution was poured off and water added—a substance rose to the surface which was ether and part of the tar. It was gathered onto a glass plate and evaporated—it left about half its bulk of a greenish brown matter, fluid like the tar and of a pale colour—it had the taste, smell, etc. of Barbadoes tar and was evidently freed from black and other matters, but still exhibited no striking chemical characters.

The same substance was obtained by dissolving some of the tar in ether, adding about its bulk of alcohol—stirring—allowing the black deposit to separate—pouring off the pale coloured fluid—adding to it a little more alcohol—again allowing the separated part to settle—pouring off as before and then adding more alcohol; if the separated matter no[w] appeared yellow the whole was evaporated and a substance of tarry consistence was obtained having the smell of barbadoes tar—brown in large quantities but on glass plates in films of a greenish colour and very different to similar films of the Barbadoes tar. This purified portion was like the former, i.e. that by ether, alcohol and water as above, but it presented no striking chemical characters.

Mr Caldecott sent me some Tar sold in this Country as Barbadoes tar. It was very distinct from true tar in its nasty unpleasant smell—in colour not the green hue of true—was much thicker—by ether a similar sort of precipitation took place, but the colours were very inferior and so was the substance obtained. Any one who had seen the two would easily distinguish those of one from those of the other. In general chemical characters there was no *marked* line of distinction between the substances; they come as bitumen together.

NOV. 30, 1828.

Some red colour from the Soc. Arts, said to be prepared by a process the same as that for Indigo.

A red power—heated, decomposed, evolving red and yellow vapour condensing into drops on platina foil and solid when cold—the drops dark red brown—insol. in water—sol. in Alcohol

and think the solution crystallizes on evaporation—sol. in Alkalies but precipitated by acids.

Vapour will burn with bright flame.

By heat in tube—much water—a little ammonia—much charcoal—not much earthy matter.

With water—cold, no solution—boiled and filtered, a faintly coloured solution but small particles come through—none seems fairly to dissolve.

With Ether—boiled—a weak coloured solution—evaporated—left a little substance of a better colour than the solution—this was not soluble in water—was readily soluble in Alcohol—not deepened in colour by mur. tin but rather injured.

With Alcohol—cold or hot—dissolves more than ether—evaporated, left red solid substance, not crystalline, having the same properties as that from ether.

Weak acids affect no solution but appear to change the red colour to yellow brown—alkalies restored the colour.

Alkaline solutions form deep coloured solutions. With weak Ammonia, filtered—a deep coloured solution—M. A. added caused yellow precipitate and on filtering the solution passed nearly colourless—the precipitate treated with ammonia became red and dissolved again.

Some of the ammonia solution evaporated left a brown substance *not readily soluble* in Alcohol—adding a little Mur. acid, it dissolved in the alcohol *more readily*.

Fresh ammonia added to the residue of the first digestion acquired very little colour—nearly all that was soluble had been abstracted at first.

The pigment mixed up with *Sul. Iron, lime, and water* and enclosed in a bottle changed in colour, but the supernatant clear liquor did not contain any deoxidized matter becoming red by exposure to air.

Strong Sul. Acid mixed with the pigment appeared to dissolve the whole, producing a dark yellow liquid and giving no smell of suls. acid even after many days. Adding this solution to water a pale yellow liquid is obtained, but by far the greater part of the substance is thrown down of a dark yellow brown colour. It does not remain in solution therefore, like indigo, on dilution.

The yellow brown precipitate and also the yellow liquid itself is taken back to red by Ammonia so that probably the Sul. acid dissolves the substance without causing its decomposition.

DEC R. 29, 1828.

Mr Phillips was here, making an experiment on the evolution of oxygen from pure native peroxide of manganese by Sul. acid—150 gr. of the oxide finely pulverised was mixed with 4·4 c : i : of sulphuric acid in a retort and then the retort, being connected with a trough, heat was applied and the acid made to boil until gas appeared to cease from coming over; after which the jar of gas was removed and the retort corked under water until all was cold or nearly so. Water was then let in until the pressure was restored at common temperatures and then the quantity of oxygen remaining in the retort marked. The diluted solution in the retort was filtered on double filters to collect all the insoluble portion, which amounted to 14·15 grains and may be considered as per oxide unchanged: hence $150 - 14·15 = 135·85$ gr. of oxide manganese were converted into protoxide to form proto sulphate—very little red sulphate was produced—unimportant.

The retort was of 33 c : i : capacity—the quantity of gas and air received was 74 c : i : at 52° F.—the quantity remaining in the retort 7·4 c : i : The bulk of the 150 gr. oxide about $\frac{1}{8}$ c : i : or say 0·2.

Hence 135·85 gr. per oxide gave 53 c : i : of oxygen or 17·96 grains.
but 135·85 „ „ ought to give . . . 24·7 „

JAN Y. 6, 1829.

Occasionally fires appear to burn with more than ordinary vigour and this usually taking place in winter is supposed to indicate a frosty air. This cause does not seem sufficient to account for the effect. Query does the air at these times really contain a larger proportion of oxygen, for that is the explanation which most readily arises in the mind of a chemist.

This evening my parlour fires were burning in this bright manner. Collected three bottles full of air from the Laboratory where all was clear and sweet, and leaving a little distilled water in each, put them bye for comparison in an inverted position.

The time was 10 P.M.: the Barometer 30.06—thermometer in the Laboratory 46° F. Temperature out of doors just at freezing.

Jany. 8th. Morning. Fires burn in the ordinary way—put by two bottles of air for future comparison.

OCTR. 29, 1829.

See Sept. 25, 1827.

Experiments in Vaporization. Examined the results of the experiments put by Sept. 13, 1826. It is now three years since they were set on and they have not been disturbed since. The box and every thing else appears safe.

No. I. Much of the water had passed from the solution of sulphate of Soda in the bottle to the Mur. of Baryta in the tube, but the remaining sol. of sulphate of soda was perfectly clear. The solution of Mur. of baryta formed was also perfectly clear, but there was a good deal of solid salt which might hide a little turbidness.

No. II. The nitrate of silver solution had given *all* its water to the chloride of sodium and the latter was covered in the tube by solution, but there was no appearance of chloride of silver in either tube or bottle.

III. The solution of Mur. lime perfectly clear—the crystals of oxalic acid dry and unchanged.

IV. The salt was dry and unchanged. The S. A. on being examined was found free from M. A.; not a trace.

V. The solution of Mur. of lime perfectly clear—the crystals of oxalate of ammonia dry and unchanged.

VI. White Arsenic unchanged. The Sol. of potash turbid and foul. On chemical examination it was found to have acted strongly upon the glass and to be fully saturated with silica, and also to have much lead in solution.

VIII. The Mur. Ammonia unchanged. Here again the Sul. acid upon examination was found pure and free from M. A.—not a trace present.

IX. The per sul. Iron its own colour and not at all blue. The crystals of ferro pruss. potash unchanged.

X. No blackness in potash as if Calomel had passed over but the potash contains yellowish filaments, as VI, and the glass

is acted upon by it. The filaments appear to be silica or something from the glass. No calomel has passed over.

XI. No cor. sub. appears to have passed over but the potash has acted on the glass and is coloured a very little and turbid—deposits in it. By examination as to appearance there had happened the same decomposition of the bottle as with VI, but this bottle was not opened.

XII. The solution of Chromate of potash has become yellow, turbid, but from the appearances I have no doubt it has been occasioned by action upon the lead in the glass. The same effect takes place in the Laboratory solutions.

XIII. The same as XII and for the same reason.

XIV. The solution of Iodide potassium is perfectly clear and colourless; no sublimation.

XV. The sol. of Mur. lime is perfectly clear. Some of the water has passed over into the tube and formed a solution of carb. soda, but that is perfectly clear also.

XVI. The sulphuric acid here perfectly clear. The Nitrate of ammonia unaltered; not in solution.

XVII. The solution of sul. copper still blue and unchanged—part of the water has gone over into the tube and formed solution there—but that is yellow.

XVIII. The Iodide of potash in the tube is in red solution as containing Iodine and the acetate of lead is dry in the bottle. All the water has passed over, but no sublimation except perhaps of acetic acid, which has caused deep colour.

All these bottles with the exception of VI were again put bye for a further period.

NOV. 26, 1829.

Action of fluid in voltaic combination.

Clean iron nails laid on clean sheet zinc in dishes with fluid so that both iron and zinc partly in fluid, partly in air. For the purpose of observing the protecting power of zinc over iron. After many days examined. Where water the fluid, action and oxidation both of iron and Zinc—no protection of iron—no serious corrosion of zinc by its contact. Apparently not more than where wood intervening. But where sol. of common salt used there iron

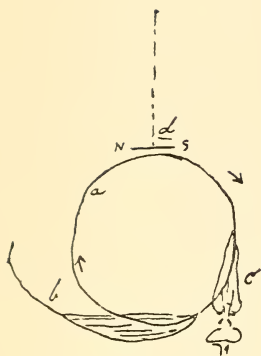
fully protected; no corrosion of it, great corrosion of zinc—when wood intervening then both corroded. Hence zinc can protect iron and iron destroy zinc in this saline solution, but not in pure water. An evidence this of the effect of chemical action, etc. in exciting electricity. The iron nail on the zinc in solution of salt had much free alkali adhering to it.

1831. APRIL 19TH.

Evening 10 o'clk.—saw aurora whilst going from Academy towards the Inn. Called at Mr Christie's—he examined the Needle and the Mag. Needle was between two bar magnets so as to have directive force diminished and altered; at 10 o'clk. P.M. the south end of Needle was at $124^{\circ}5'$ —by $\frac{1}{4}$ p. 10 it had gone towards the East to 146° and in a few minutes more it had gone further east. There was one very fine streamer during the time and that time needle vibrated much. The mode of going back, regular, etc. as it was, shewed that it was the Aurora that affected the needle. There can be no doubt about it.

1831. MAY 30TH.

A silver wire ring (a) was so put into a vessel of water (b) that a part could project over the edge and be heated by a spirit flame (c) whilst a little magnetic needle (d) suspended by a long delicate silk fibre hung over the top. The ring was then moved in the direction of the arrows, so that each part became hot and was then cooled suddenly in the water. No effect on the needle was observed, nor when the needle was perpendicular to the plane in which the wire moved. The expt. was made to ascertain whether, as the heat travelled from particle to particle, any electricity was put in motion.



AUG. 18, 1831.

Was yesterday at the Bank looking at Mr Perkins' mode of heating blocks for use of copper plate printers by circulating hot water. Raised the pressure to 100 atmospheres and then temp. by thermometer was 420° F., but the pipes themselves must have been hotter. Now chars wood and tow at once, i.e. makes it brown—inflames sulphur—inflames tow sprinkled with sulphur—

fires a match—fires gunpowder—did not inflame tow, oil, rosin or paper when alone.

Probable causes of danger, a blow on hot substance which by friction or compression of air might raise heat.

Evaporation of water so that very hot steam might circulate.

When water partially evaporated then assumption of Cagniard de la Tour's state without great increase of pressure, and then over heated state of steam in some parts of apparatus beyond others.

AUG. 19, 1831.

Made a few expts. in a bent tube placed in heated oil. Even when oil boiled (at 580° or 600°), tow, rosin and paper, though charred in the tube, did not inflame.

After the oil had boiled a little while, the vapours inflamed spontaneously, and the vessel being taken off and placed on the ground, and the flame extinguished by putting a board over it, the vapours reinflamed upon opening the vessel to the air; and that took place when the liquid had sunk to 540° . The vapours often inflamed much above the pan (a foot for instance), the flame descending to the pan.



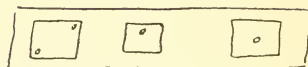
MARCH 29, 1832.

Have put six pieces large and small of plate glass into the sunshine on boards against the wall of the house outside and beyond the lecture room on the leads. The pieces are shaded more or less by black varnish and paper, etc. etc. and are to remain for the summer.

One piece being *part* of one of those put out I have kept within doors in a dark cupboard.

1832. SEPT. 8TH.

Took a planed board, not painted or covered, put in some screws in the places marked, making their heads flush with the board. Then varnished the board in those places with white hard varnish so as to attach three leaves of dutch foil to the wood in such a manner as to be in contact with and to cover the screws, as in the figure. Left the whole until the 10th, and then put it out in the rainy weather with the unprepared side uppermost, so that



the wood might get damp and that voltaic action might go on and also ordinary oxidation of the leaves.

Novr. The rain has washed off the copper leaf and no distinct results have been obtained.

14TH NOV. R., 1832.

I and Daniell went today to see Mr Cary's gas microscope. He uses the light of a piece of lime ignited by the oxy hydrogen flame.

Made some experiments on the refrangibility of the rays of heat from this source and the chemical action also of the radiant matter.

Found that a luminous focus occurred on the outside of the arrangement of lens about half an inch from the last glass. Here the back of the finger was actually burnt, the pain being more than would willingly be borne. Found that the heat in that focus (and only there) was enough to fuze and then inflame phosphorus—that it affected a differential thermometer.

On putting a little fresh and moist chloride of silver in the focus for a minute, a dark stain was produced at and round the center of the focus which was entirely superficial and therefore not due to the chemical action of the paper. The chloride below the surface was quite white.

On trying the effect when no lime was used, I thought I could perceive a little heat on the finger, but it was as nothing compared with that of the lime radiation.

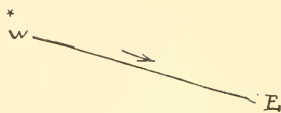
The lenses remained cold to the finger during the experiment.

The sum of the thicknesses of the lenses, i.e. of the glass through which the rays passed, is about $1\frac{3}{4}$ inches.

Hence lime raised to this temperature, besides evolving intense light, evolves rays of heat which pass through glass without heating it and are refracted freely to a focus—and also emits rays producing chemical changes like those from the sun.

Evening of Oct. 1. 1833 at about 5' before 7 o'clk. I was in a coach on the lower Woolwich road looking over the marshes towards the North. A meteor appeared—very bright—it threw out sparks behind it in its course and had all the appearances of

combustion—the sky was clear there and the stars visible. It described a path from West to East directly in the north of about the inclination above*. Its mean height from the horizon was about 20° or 22° and the extent of the path visible to me about as much. It was very beautiful and bright. It left no line behind it, only the sparks, etc., which had separate existence for the time.

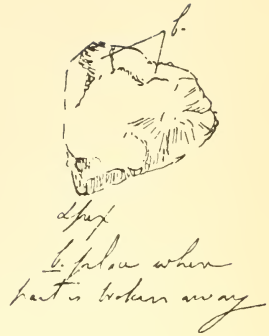


FOLIO VOLUME I
OF MANUSCRIPT

FEB. 1828.

METEORIC STONE was of a flattish form and angular shape; crust over the whole surface except where a portion had been broken away; a fresh part broken out in same neighbourhood, i.e. farthest from apex. Stone tough, shivers and has a tendency to divide parallel to its upper and under surfaces when lying flat, and from the apex to the rounded edge. It is as if the piece had a stratified structure; they extend almost through the stone and divide the solid part into layers from the $\frac{1}{8}$ of an inch to half an inch or an inch in thickness. When the division was carried through these cracks the surface exposed was very remarkable and very different to the cross fracture of the stone. The surface had the appearance of a mica slate but in place of mica the flat particles present had a brilliant metallic lustre and proved to be thin plates of metallic iron; where the surface had been exposed by former fracture these had rusted and become red. The metallic lustre was not so bright as clean iron but more resembled that of plumbago or sulphuret of molybdenum. Another remarkable thing on this surface was that it was irregular like some kinds of slickensides, or like the chalk of Carisbrook which has slipped one part over another, so that long elevations and depressions like furrows, etc. existed quite like those in the Carisbrook chalk; and then these line[s] and marks were not strait but as far as they could be traced on a surface about 4 inches long and 3 broad in the widest part they were curved, having a direction nearly concentric with the round edge or limit of the stone on that side and respecting the apex very nearly as acentric. Supposing this stone a piece of a large mass of which the apex of the present had been the centre, it would seem as if the parts of the stone had rotated or slid one over another and so have neared this slickenside state in different parts.

The appearance of the stone in the cross fracture was very different. It had a spotted earthy aspect, a light bluish grey colour being the general tint, but there were brown spots here and there and by the lens minute points of brilliant metallic iron could be perceived in all parts of it. The appearance of the stone however varied in different parts, even of the small surface opened out. In some places it assumed the appearance of a decomposing porphyry,



in some of a porphyritic basalt; but in all parts were the minute specks of iron, in none any glassy points or crystalline brilliant matter. Sometimes the particles of iron were of a larger size. Towards the surface of the stone or where it has been broken and exposed to air, etc. it is much spotted with red rusty dots, as if oxidation of iron had taken place in numerous points and spread from them as centres; these spots were irregularly in form and disposition from the $\frac{1}{16}$ to the $\frac{1}{8}$ of an inch in width, sometimes running into each other, sometimes not.

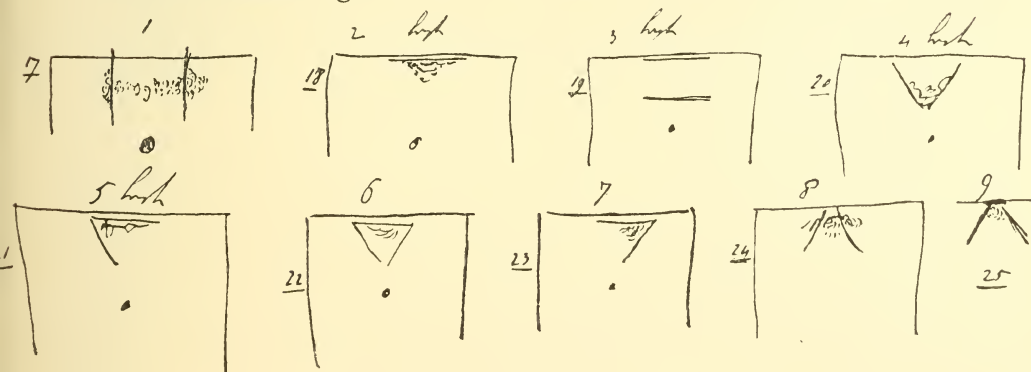
In the cross fracture the stone a good deal resembles that from Benares.

Having been allowed a few days after to open the stone still further, it was found that wherever there was a tendency to divide as before described, that the micaceous surface of iron was shewn. Parts of as many as 4 and even 6 of these surface[s] were shew[n] and the striæ or furrows all preserved a certain degree of parallelism and might be considered as respecting the apex as a centre. With regard to the cross fracture, in one part towards the side it was veined like a piece of marble, the veins being darker than the other parts and there the stone looked like an old lava.

ACOUSTICAL FIGURES

FEB. 2, 1831.

1. *Phos. lime*—fine one place—coarse another—finest will collect at centers of vibration even on very inclined plates.
2. *Silica fine*—very good—all at centers.
3. *Carb. mag.* intermediate, some at centers, some at lines—little involving heaps in all parts—hence that motion common to the whole plate where vibrations occur and not to centres only.
4. *Magnesia* Do.
5. *Red ox. iron* to lines, even when rubbed with sand.
6. *Carb. copper*—good—at centres, all if finely rubbed.
7. *Carb. lead*—little finest at centres—rest at lines. Do. with Sand.
8. *Per-ox. tin* by far the best as yet and also had little adhesion with itself.
9. *Red lead* very pretty; though so heavy, finest still keeps at centres and rest descend slowly to quiescent lines.
10. *Vermillion* nearly as red lead, but more tendency to lines.
11. *Calamine* settles slowly at lines—almost neutral.
12. *Sul. bary.* fine to centres—coarse to lines—nearly neutral.
13. *Sul. lime* nearly neutral in effect—fine and coarse, etc. etc.
14. Washed powdered Glass very good—next to ox. tin—heaps are angular, not round.
15. Long plate with two nodal lines—Silica—*along middle* and not at equal distances.
16. Silica on edge of plate on table, other plate edge vibrated near to it, silica carried or blown from one to the other.
- [17–25, see diagrams below.]
19. 3 indifferent as to inner card, collected ultimately close to outer—note not much lower—form of cross not changed.
20. 4 collected towards the corner.
21. 5 then went towards corner.
22. 6 towards edge.



23. 7 towards corner.

24. 8 little way from upper but when closed as in 9, then quite up in corner.

26. Gold leaf over place, entrance of air here, there, etc. insinuation of silica under.



27. On long plate—with card—lateral motion.

28. With card—lateral where none, lay along and by card where card, when card laid flat in same place then motion as without the card. Proof.

FEB. 3, 1831.

29. Plate with water on—appearance as usual—could not hold steady enough to see whether accumulation of water at 4 centers but think there was indeed must have been because it travelled over the edge. Sand with water collected at quiescent lines, nodes. Silica or liquopodium did not collect at centers though there it took form. Mutual repulsion of fine floating particles probably far too strong. Appearance of vibrations, etc.

30. As usual. Ox. tin—moistened yet dried body did not seem much disturbed as to locality under water—did not collect either at lines or centres.

31. Funnels with vellum and horse hair shew effects in air excellently well.

32. In water but air in funnel—both Sand and filings gathered to the middle, even though up hill—and also when water on both sides—they gathered to middle whilst parchment taught but

33. when it slackened then they settled in irregular points but not at edge.

34. Air pump Exp.—*good*. Round plate on four cork legs, rod of glass through cork with pomatum resting on plate at middle—made to vibrate by wet fingers—did pretty well—vacuum exhausted to 28 inches—*fine silica* not moved from edges but went from *middle* towards nodal lines—on letting in air and repeating vibration then silica left edges and took up usual place from nodal lines and some went back towards middle—glass then broke.

35. Expts. in water with Anderson—Round plate on three crucibles—vibrated by glass rod held tight upon it and

fingers applied, nodal points held tight by sticks above—on vibrating plate, both filings and sand went to centers and when a part so covered with filings was placed over a node or resting point and plate made to vibrate the filings travelled from that point of rest to the centres of vibration. The way in which they went in from the edge forming a ring all round and also the collecting of them at the place where the rod touched were both striking of the collection at places of greatest vibration.

36. Tin plates fixed at one end and vibrated by fingers shew also the progress of the air and the light powders with it.

FEB. 4TH.

37. Funnels—one  with parchment *oiled*—in air as usual—in water—filings and sand very well to centre when lower part of funnel contains air—when lower part water, then subdivision, the edge and a circle nearer the centre lines of rest and there no filings. The centre and a circle towards edge places of vibration and there filings, the filings in full motion like liquopodium in air.

38. Same exp. with linen instead of vellum. In air, fine silica passed into and through the linen but tended to middle, filings and sand off, but in water both filings and sand to middle or place of vibration.

39. Long bar in line thin paper at edge—go to paper either side.

40. Funnel in Exhausted receiver, horse hair, etc. etc. little inclined when exhausted, tendency to edges or almost indifferent, but when air in decidedly to middle and powerful. Effect very good.

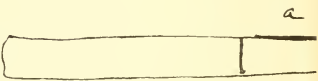
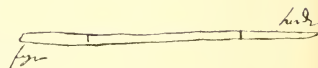
41. Paper frames—with horse hair cemented in, shew working of light powders very well indeed, some beautiful arrangements.

42. Long plate, liqupd. in lines, but on cementing piece of paper at *a*, so as to extend above and below then powder towards it, yet should still more have deadened any internal vibrations.

43. Involution of heaps is another effect and is from centre outwards above in whatever part of the plate the heap stands and not from centre of vibration outwards only.

44. Funnel fixed on stand with vellum etc. shew[s] effect exceedingly well.

45. In smoke of Naphthole—current of air, etc. evidently not exterior, soon return.



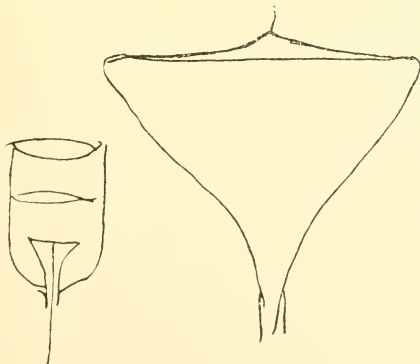
46. Brass plate and Smoke does not do well.
47. Large thin tin plate and sand and liquopodium same as fine plates except that jumps, etc. coarser.
48. Do. Plate—if gold leaf quite on then travels towards end, etc. as powder does, if only a little off at end then quickly blown off entirely—air gets under in another way and the effects are quite different.
49. Tuning fork good, liquopodium in fine heaps and lines, etc. etc.
50. paper on one edge—powder to it—on other edge, powder to it.
51. on different sides in different parts—still to it where paper.
52. Crispations happen as well oil as water if a little heated.
53. Plate of tin, long, in water surrounded by $1\frac{1}{2}$ or 2 inches on all sides. Sand on plate vibrated by stick pressed upon it, etc. Sand collected in line at middle. On trying upwards vibration only, sand collected from edges *towards middle* almost while none being thrown off, though opposite result was expected. On trying downward vibration then sand towards edges thrown off in shoots but that towards middle collected at middle. Although reverse of what expected yet cause easily seen if a single vibration or half vibration be made. In first case sand in centre and held on until return water pushes it. In second sand left behind because of Greater S. G. and consequently is off the plate and return water pushes it right and left with itself. Well seen and explains why on plate in air liquopodium not quite close to the edge.

FEB. 8.

54. On glass rough on one side smooth on other nearly equal appearances. On round plate of Plaster cast on glass, form of cross, etc. very distinct, but liquopodium travels fast to quiescent line and it is very difficult to keep even a little at centres of oscillation.
55. Funnel and parchment, hair downwards—glass plate close over vellum: then gathering to centre very powerful, far more so than at distance, and then also the heaps are often linear and concentric and not hemispherical—tends to prove that heaps do depend also upon currents of air, etc.

56. In this way Carb. mag. gathers slowly without glass, quickly with it.
57. Sul. lime collects with difficulty in open air but *well* this way.
58. Calamine nearly the same not quite so good.
59. Ox. iron nearly as calamine except that rather too heavy.
60. Carb. Magnesia the best—shews the long concentric involving lines also best inwards below and outwards above and therefore rolling.
61. Carb. lead, place of rest both ways at edge of funnel.
62. Sul. bary. as before, except that it is assisted in collecting by the upper plate.
63. When plate put close down upon funnel and held tight down then liquopodium travelled from middle towards sides because as hair was downwards the vibrations up were quicker than those down and therefore air thrown out had greater velocity than that entering and as force is as square of Velocity therefore liquopodium outwards, just reversing the course of powder, yet clear that supposed internal vibrations not altered.
64. Funnel *old* under water—hair upwards, filings and sand on parchment—they settled away from middle but still shewed tendency towards it where in contact with skin and they did not collect at edges but in places where they suffered violent agitation. The heaps were often semiglobular and then involved I think like liquopodium both of sand and filings. When funnel out of water and hair held taught the curve of surface was quite as much as below, thence good reason why not settle at middle.
- 65*. Another funnel under water thus—here filings to centre and evidently swept there though of course cone downwards was in its favour but there was also another or many other centres of vibration, and there filings rested—involving exactly like liquopodium on glass.
- 65[a]. Expt. in Vacuo. New tympanum, horse hair through paper, cork, pomatum and at top water—found water entered—by putting another cork at top with water and [illegible] pomatum in, obtained perfect tightness—then at 28 inches moderate vibration liquopodium passed across the diaphragm to one (the lowest) side being agitated but not collected. With very strong vibration more cloud at middle than elsewhere but still not collection. At

* [65]



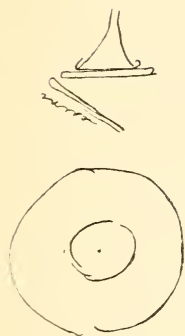
26 inches nearly the same with strong vibration faint traces of cloud collecting at middle but no accumulation of powder there. At 24 inches very little effect of *return* and tendency to little accumulation at middle—at 22 inches rather more—at 20 very fair collection at middle, then exhausted to 28 inches and appearance again as at first, what had collected passing towards lowest side again. Then brought it to 16. Collected well at middle, and when all there exhausted to 28, and again repeated, powder gradually passed to sides again.

65*b*. When powder uniformly spread and exhaustion at 28 observed that heaps formed very beautifully over whole surface though more immediately towards middle than else where, but the heaps were much flatter than when the pressure was at 16 inch or as in ordinary circumstances as if absence or attenuation of air had flattened them. As air was let in the height of the heaps increased most distinctly, evidently an influence of air over them.

Again observed that when receiver was exhausted the powder purposely collected at the centre was not thrown so high or with so much force upwards at the middle as when receiver full of air. Difference very striking; in latter case spurted up in jerks like a fountain, in former rose a very little way. This should have been the reverse if the powder had been thrown up only by the vibration of the tympanum and proves that it is thrown up rather through the medium of the air—it ought on the first supposition to be thrown higher in vacuo than in air because then no resistance, but the contrary was the fact. The little heaps involved in vacuo but not so strikingly in air. Query the effect of hydrogen and Carbonic acid?

FEB. 18TH.

66. Expt. with funnel upside down on plate of glass and effect observed by Mirror, liquopodium on glass plate. The liquopodium mostly thrown out by more rapid motion of air out than in, but there was a part which involved in a circular area about the middle point about one third of whole diameter wide: here neither thrown out or gathered in, but went in at surface of parchment and out at surface of glass. Same effect if funnel and glass plate set upright.



67. Large Expt. started, drawing paper on frame 3 feet by two and a spoon full of lycopodium; tapping and striking beneath, very good gyration results.

MAR. 14.

68. Diaphragm and hair-lamp glass above—certainly collected powder fast at Edges. When held up, diaphragm vibrated and then glass lowered over powder, it was quickly seen how by approaching the powder it caused it to fly more rapidly under its edge and towards the middle. A funnel did not do this, nor a tube nearly closed, for then air went *to and fro*, not in *one* direction principally.

69. A piece of upright paper did not do it but a chimney would. Went to large drawing paper stretched on frame—there on spreading the lycopodium over surface, then tapping one part to make whole vibrate and holding lamp chimney over any part, powder immediately collected to the middle of space beneath and that wherever the glass was. On moving the glass the powder could be carried with it. On closing top of lamp glass then also collection but powder went in and out and part blown back, etc.; space below edge swept very clean. These all natural and shew modification of the currents of air formed by vibration. Funnels as the close tube mainly—contracted tubes half way between open and closed. In open tubes direction principally one way. Nothing can shew lateral currents better than these expts.

70. Mica ring on surface of diaphragm—concentric lines.

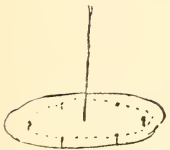
71. Silica Chimney (glass) suspended so as not to be warmed and hands at great distance above. No decided evidence of current upwards, rather proofs of none, but collecting power of the chimney very distinct—appearances very different as nearer to or farther from diaphragm. When near to, revolving at Edge as if double current not high in extent—not far from the membrane—still all in favour of the influence of air, nothing against it.

72. As to rotation of particles, necessary consequence if consider that [they] are lifted up in air and then support taken suddenly away—outside edge, etc. carried down first.

EXPTS. MADE 1831. CRISPATIONS

JUNE 17 AND PREVIOUS.

- 1.* White of Egg a very good thing for crispations.
- 2.* Crispations almost always quadrangular, always when well formed, but modified by edge of water or liquid—also by centre of motion.
- 3.* Water on glass—crispations at centres of oscillation always.
- 4.* Drop of water on plate of glass upside down, drop hung down but on vibrating plate the drop crept up gradually and water spread laterally on the plate instead of being accumulated further at drop and thrown off. When plate quiet water *by gravity* returned and formed drop and this drop by vibration spread again laterally. The agitation at apex of drop formed little globular jets (at first) hanging as it were by a pedicle, but these were not thrown off and soon diminished, passing into the lateral expansion. It seemed at first as if water forced from centre of vibration instead of to it.
5. Seems as if the thickness of the stratum of water on the plate above or below must have a certain relation in thickness to the force (mechanical) belonging to the parts of the plate beneath. Is not this and the lateral expansion in favour of reciprocating waves, i.e. very peculiar stationary undulations.
- 6.* The effects of stationary undulations of the ordinary kind which are formed with low vibrations and are much affected by the form of the puddle, etc. and the limitation at the edges ought to be carefully distinguished from the true crispations.
- 7.* Cold oil rarely shews crispations, hot oil readily.
- 8.** Made experiments with Young's table so as to have no limit to the water over the vibrating plates, then all influence of returning waves prevented and no stationary undulations of that
9. kind produced. A circular plate of glass with 6 cork feet attached in nodal line, the plate stood upon these and thrown into vibration by a glass rod resting at middle and rubbed in finger. This placed horizontally in water on Young's table till surface covered about $\frac{1}{8}$ or $\frac{1}{10}$ of inch—then vibrated—crispations beautiful—first in circles from center outwards, ceasing



before reaching the nodal line—beyond nodal line began again, rapidly rising in intensity and being radial to and beyond the edge over the surrounding water, but immediately beyond the edge crossing circles were formed continuing outwards.

10. When the vibration was stronger then central portion sometimes broke up from rings into heaps or elevations, but these tended to be hexagonal and were hexagonally arranged and sustained with difficulty. With stronger vibration the crispatation near the edge became tumultuous and broken but not rectangular. The beating of the water at the edge of the plate interferes and

11. produces the circular crossing waves there. Pieces of cork put on to the water were driven out from the center and inwards from the edge tending to rest at the nodal line or quiescent part but always agitated.

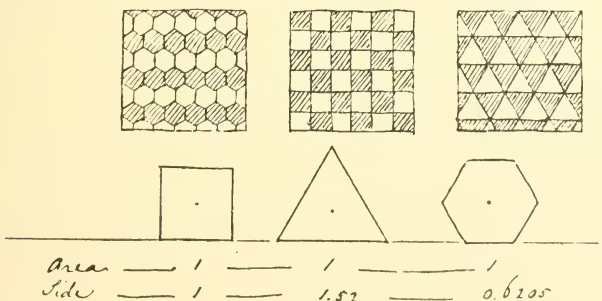
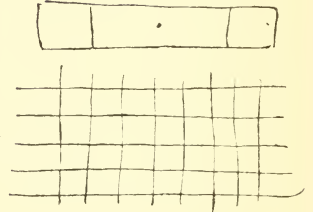
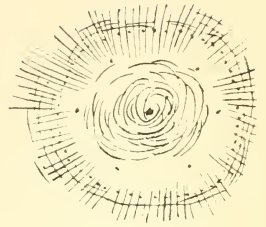
12. Sand strewed on the plate had a tendency to gather into little heaps but the tendency was very small and uncertain. It was nothing like what happens with stationary undulations.

13. The long plate was put under the water and vibrated similarly, but the lines usually formed depended upon interfering undulation from the edges beating the water; when the crispatations appeared they were large as the diagram about and generally regular and quadrangular, the lines being parallel to the sides of the plate. Sometimes they were confused.

14*. It is very evident that the quadrate form of the crispatations or waves is the natural one, for in that form the distance which the particles have to move through is the shortest possible distance i.e. considered in relation to the courses which they would probably take and the number of these courses. In that arrangement the dividing lines are the shortest possible also, and other physical reasons suggest themselves to be considered hereafter.

15. Again, if as I suspect the elevations are alternating and exist in the manner of stationary undulations, i.e. up and down motion, then linear or triangular or quadrangular—hexagonal?—are the only arrangements that are admissible as capable of alternating—linear are first formed and these readily break up into quadrangular by increased force.

16. The forms at the commencement and the place also of the crispatations are much influenced by the depth of water—the edge



of the pool, the edge of the plate—somewhat by the direction and nature of the vibrations of the plate itself, etc.

17. When the quadrangular arrangement is oblique to the plate used and the vibration is steadily sustained they gradually wheel round in mass until parallel to the edges.



JUNE 18, 1831.

18. Expecting accumulation of fluids at centres of vibration I used oil (cold) hoping its viscosity would enable me to observe curve formed on surface or else a lens like action there. Took a square plate, put oil upon it, gripped it about *c*, applied the bow at *x* producing the note which had with sand previously given the nodal lines marked or thereabouts. Immediately oil collected at *a* and *b* and on looking at small printed paper through the plate and oil these parts acted as lenses. On withdrawing the bow the oil flowed back to level—on renewing vibration it again went to *a* and *b*.



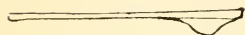
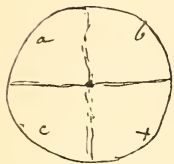
19. The oil being yellow even the difference of colour on looking at white paper shewed the accumulation at *a* and *b* whilst vibration continued.

20. On using a round plate held at middle and agitated by the bow at *x* the accumulations of oil at *a*, *b* and *c* were as beautiful and distinct when thus looked at as if lycopodium had been used.

21. Then inverting the plate so that a drop of oil should hang from *a* and *b* down some little distance and vibrating it, the oil instead of being still further accumulated and thrown off as a drop, gathered up and expanded laterally until it formed a lens of nearly if not quite equal power as in the former cases. The mere gravity of the drop seemed quite lost in the superior powers brought into action by the vibration of the plate and the cohesion of the fluid, and it appears that the oil arranges itself in a layer proportionate in some manner as to its thickness in any part to the vibratory state of that part. See * on water June 17th of same nature. Hence there is only a gathering with fluids at the centers of vibration to a *limited* extent.

22. The notion of reciprocating waves or elevations gains ground in my mind.

23. On experimenting with white of Egg, as with the oil—it also shewed the accumulation at the centers of vibration—and as



that substance shews the crispations well, it was very beautiful to trace the effect first to accumulation (lens like), then by increasing the force of vibration to see the first wrinkle appear, next quadrangular crispations and finally jets in the air upwards so as to convert the egg into froth.

JUNE 20TH.

24. At work with long plate (June 17. § 13) but not in Young table. It was put on its bridges, water put about the middle and then the plate vibrated by a wet glass tube resting at *a*. It was easy to make the crispations so powerful as to overcome all ordinary stationary vibrations. The crispations were as usual almost always rectangular, sometimes a little confuzed—etc.,—they were perhaps $\frac{1}{8}$ of inch across—they seemed square.

25. A candle image reflected from surface and examined presented a similarly formed figure on each heap or elevation, but these were not fixed, but travelled, forming endless figures like those of the kaleidophone, that on one wave being exactly like that on another. Does not this shew that the waves are reciprocating, i.e. continually moving to and fro one into another?

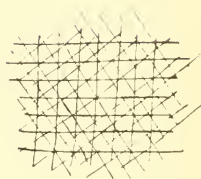
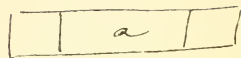
Supposing that this might in part be due to the motion of the plate itself up and down, which would carry the waves even

26. though they were permanent elevation[s], the candle was so placed that the incident and reflected ray was nearly perpendicular to the plane of the glass and parallel to the direction of its motion, yet the images travelled as before. Must make permanent elevation[s] of resin or other substance and see how they appear under the vibrating state of the plate.

27. On examining action of sand on plate: Much sand with little water formed large heaps, involving in a beautiful manner like lycopodium in air and exactly analagous in cause.

28. Less sand and more water gave confused results. Very little sand and plenty of water gave sand figures resulting directly from crispations, but these always appeared to be as square heaps, one for each wave (perhaps?), placed in lines; but these lines at an angle of 45° with those of the waves. Thus when waves were as black ink, sand spots left were arranged as red ink.¹ Must work these out as to number, position, etc. the first thing.

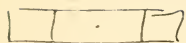
¹ In the original diagram the diagonal lines are in red ink.



29. The ripple or crispation continues of the same width sensibly whether barely formed or whether plate vibrates so powerfully as almost to throw up drops.

30. I used coloured water to ascertain whether whilst ripple existed one part was more luminous than another, but I could not determine the point for want of some mirror adjustments—but it is a good form of experiment.

THURSDAY, JUNE 23.



31. Experimented altogether with a new long plate marked *c* and which gave slower vibrations than the former (marked *a*).

32. Each elevation is decidedly a little nipple, cone or hill, but it often happens that reflection from one to another gives many figures from each cone, though only one window or other light be used. Some highly polished silver cones arranged as these cones or heaps gave for the inner ones each 8 reflections at the sides, one direct at the top and vague but luminous reflection from the lowest parts; the window being over head.

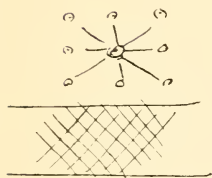
33. Will endeavour to call these cones *heaps*. These heaps arranged in a quadrangular form when most steadily, the lines of arrangement being general at angles of 45° to the side of the plate.

34. There should not be too much or too little water—a certain quantity is most favourable.

35*. Sand upon plate was decidedly washed *from under* each heap—obtained some beautiful sand figures. The sand formed lines between each heap parallel to their arrangement as in first figure but often in pieces as in second.

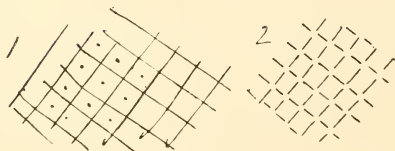
36. The pieces of the second figure were sometimes small as thus†—and when these happened to be thick as well as short they put on the appearance of heaps of sand arranged in directions opposite to those of the waves, i.e. at angles of 45° .

37. With this plate *c* 10 heaps equalled in length 3 inches: with less depth of water more hills were formed for same note or vibration, i.e. $11\frac{1}{2}$ heaps in 3 inches, and when more water was put on as few as 8 heaps in the 3 inches. The extreme numbers for



* [35]

† [36]



the same note were 8 and $11\frac{1}{2}$ in the 3 inches. These were with square heaps or square arrangement.

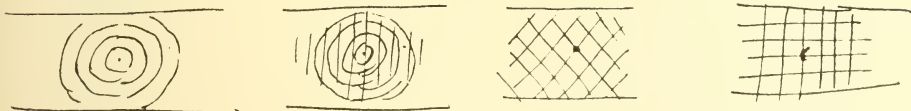
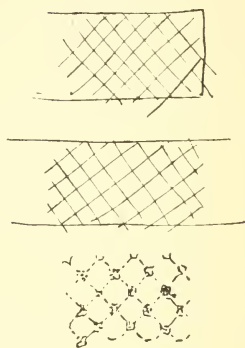
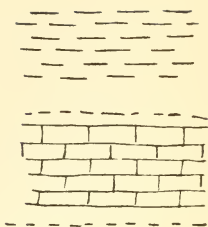
38. Then another form of heap and sand lines occurred. The kind of heaps I have often seen before, thus arranged together something like bricks, and the following marks may be supposed to represent the summits. The sand lines were not in pieces but complete and defined and as in the margin. The sand was deposited between two neighbouring heaps as in former cases, and the heaps and lines were parallel to side of glass plate: the dotted lines represent the edges of the plate. There were $8\frac{1}{2}$ sand intervals (and consequently heaps) in the 3 inches longitudinally taken, and 15 in the same space taken across the plate.

39. Then again the heaps formed quadrangular and equi-oblique to the plate as in margin, there being $11\frac{1}{2}$ heaps in 3 inches; but now sand instead of being deficient at crossings accumulated there in squarish masses, but still a few particles connecting.

40. Then again; on obtaining quadrangular arrangement at angle of 45° with edges of the plate, and with little water so that $11\frac{1}{2}$ heaps occurred in 3 inches, the sand now accumulated at the points of intersection instead of being as in a former case absent from them altogether; it formed squarish masses, but still a few particles connected these one with another shewing the primitive direction.

41*. The system generally begins by circular waves or heaps concentric to glass rod, and these form circles of sand, the sand being as before from under the elevated portions of water and consequently alternate with them—a spot of sand forms the center; at the same time there is a tendency to form linear heaps across the plate and parallel to each other (due probably to the evident mode of vibration assumed by the plate) and to the bridges, but strongest at the middle distance; these break up the circles and are themselves broken up, producing the independant heaps, at first rather irregular but almost instantly assuming the quadrangular arrangement at angle of 45° to edges of the plate: then these have a tendency to rotate through 45° and become parallel to the sides of the plate, and though they sometimes start back again their tendency is to remain in that parallel state.

* [41]



42. With the preliminary circles there are about 10 waves or intervals in the 3 inches.

43. On spreading lycopodium *on* the water and sand at bottom the lycopodium could be made to arrange in crossing lines, rather thick, but leaving clear places over the heaps and the lines being over and parallel to the sand lines. When both were well formed the lines and figures coincided accurately, but the sand far the best to shew the figures.

44. The lycopodium moved about over the whole surface of the water suddenly and in starts, as if quite independant of the heaps and urged by some other cause. The surface of the water was evidently moving about without affecting the place or form of the heaps and having no relation to them, as the motion was in many opposite and fanciful directions at once, the heaps being quite fixed in place and permanent. The direction of the vibrations in the glass—the wind of breath, etc. were probably affecting causes.

45. I had a piece of silver plate punched up with nipples representing the arrangement of heaps; these nipples each gave many reflections of the light or candle as before explained—but being fixed to the plate and the plate vibrated—the figure described by the reflected light was always a straight line (as it ought to be) perpendicular to the plane of the vibrating plate and shewing beautifully the *extent* of vibration. On looking down upon the nipples then the images appeared to be nearly fixed. This tends to shew that with water heaps the travelling of the reflected image is due to variations in shape of heaps and not to their rising or falling simultaneously with the plate.

46. A bead will be useful to shew extent of vibration required for any heap of water.

47. Tried to obtain very large heaps. Filled a flat dish with water, put it on long table flap and lifted it up and down. Got something like heaps, very large. Try still larger scale next.

JUNE 25TH, 1831.

48. Made some very large expts.—A deal board on two stools. Board 18 feet long, put Young's table in the middle—with little water, and then vibrated the board; got quadrangular

arrangements each several inches (4 or 5) in the side. They look like crossing waves but I believe they are the phenomena in question.

49. Brought the stools nearer together so as to get quicker vibrations, then had the heaps, etc. about $1\frac{1}{2}$ or 2 inches wide each; looked exactly as smaller in some cases in others as four crossing waves.

50. The proportion of water requires adjusting.

51. Although same phenomena probably as that produced by action of four right angular and opposed waves, yet cannot originate so: originate at center of motion and the 4 waves instead of being the cause of the heaps are probably the effects of them.

52. The heaps are not permanent, they rise and fall like stationary undulations.

53. Endeavoured to ascertain whether all rose and fell together or alternately—resume this next time, but believe that for any one heap it rises once or completes its cycle of changes in *two* complete vibrations of the supporting plate.

54. Then made expts. with strong laths, about 2, 3 or 4 ft. long, $1\frac{1}{2}$ inches wide and $\frac{1}{2}$ or $\frac{1}{3}$ of inch thick—these supported at each end on bridges—then a plate of glass put on the middle covered with water, and the vibrating rod put on that and the whole thrown into motion by the wet hand or fingers gave beautiful arrangements, evidently the same as those on glass plates giving high sounds and as evidently the same with those produced on the plank. Their number from $2\frac{1}{2}$ or 3 to any larger number in a linear inch. Very beautiful.

55. Ink shewed them with extreme beauty, the extra reflection from below being done away with.

56. Cold olive oil could be made to give the larger heaps though not the smaller—being warmed it gives the smallest—all depends upon the cohesion. White of Egg good because easily mobile to a little distance. These effects afford a curious illustration of the cohesion of fluids and may probably be usefully applied. Should be pursued.

57. Can now pass at pleasure from smallest to largest arrangements.

58. Evidently not *caused* by interfering waves, although resolvable into them. For if water is dished then the phenomena begins at and proceeds from the middle continually though the waves are as continually lost at the edges. Besides, however irregular the edges are the arrangement may be rendered quadrangular.

JUNE 28TH, 1831.

59. Made experiments with Young's table and the plank, taking about 9 feet of plank between the bearings. Used milk as the fluid instead of water. It has more cohesion and therefore does well for large arrangements, and by putting a candle beneath, the translucency of the milk shew[s] beautifully where the heaps rise and descend and the course of the waves formed. In these large experiments linear waves often begin from the side and form intersection, closely resembling and in effect the same as the crispations when the 4 sets cross accurately, but these are soon broken up and the effect is seldom regular. In these large experiments the heaps may continually be considered as stationary undulations formed by waves, but as before stated, they themselves form the waves.

60. The Elevations in this large arrangement certainly alternate, i.e. they not only rise and fall, but when one is up its neighbours are down and vice versa.

61. Wires laid into the liquid produced no particular or determining effect.

62. Soaked some saw dust in hot water so that it would sink: used this instead of sand under the water in these experiments. It shewed exceedingly well the alternate rising and falling of neighbouring hills, being washed from under both and oscillating to and fro in the part between, in which in smaller arrangements the sand rests.

63. Each heap recurs at two full vibrations, but as there are two sets of heaps a set exists for each vibration.

64. With very large vibrations and much water (board 18 feet long) still effects generally the same, heaps still alternate; see then better the sets of co-existing heaps.

65. If considered in relation to the waves which may be supposed to form or be formed by the heaps, all the heaps which

exist at once are in rows parallel to the direction of the waves, thus,¹ or thus, these being the two sets: but as in consequence of durability of impression on the eye both sets are seen at once, the arrangement of the heaps seems to be at an angle of 45° with the wave thus, or thus.

66. On using a quadrangular frame of wire and striking the water with it so as to produce four sets of waves at right angles, the elevations as above were produced at angles of 45° to wires.

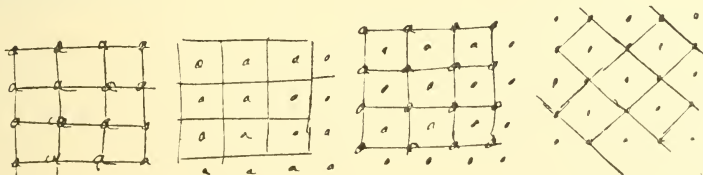
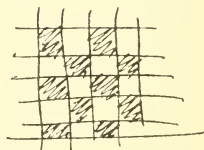
67. Then used a smaller arrangement, a lath about 3 or 4 feet long, $1\frac{1}{2}$ inch wide, third of inch thick. A glass plate 8 inches in diameter was cemented on and the whole vibrated by a glass rod and the fingers as before. A mixture of half water, half ink, was used. A beautiful arrangement very regular was obtained, there not being above 2 or 3 heaps in the linear inch. The arrangement could be sustained for any time almost unchanged in place.

68. The plate was then surrounded by a border of wax or soft cement so as to hold plenty of fluid over its whole surface. The ink was much further diluted—a beautiful and perfect and constant formation was obtained.

69. On looking at white paper beneath, a peculiar chequered appearance was perceived in consequence of the different quantity of fluid on different parts of the plates: lines of a certain intensity divided the heaps from each other, but the square places representing the heaps looked generally lighter. On, however, taking a position in which no reflected light, or but little, came from the surface of the heap, then the places of the heaps could be perceived as dark from the greater depth of ink there, and on looking more minutely a position could be found in which the whole surface looked like an alternate arrangement of white and dark chequers—the dark becoming light and the light dark alternately. In this way the alternating action of the two sets of heaps was most beautiful.

70. It required tact to observe this effect and the chequers could be seen light or dark all at once very often by merely making an

¹ Four diagrams are referred to in this paragraph in the order in which they appear below.

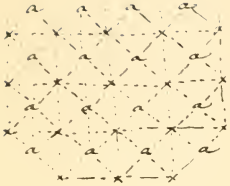


exertion with the eye either to see the one or the other. This is because of the rapid alternation of the two.

71. The heaps were conoidal—the candle image travelled beautifully.

72. On replacing the diluted ink by water, sand arranged beautifully.

73. On putting a candle exactly below this plate and holding a screen of tracing paper an inch above it, the picture given was beautiful. Each heap gave a star (α) of light at its focus which twinkled, i.e. appeared and disappeared with the heap continually as it rose and fell. At the corners (χ) a fainter light appeared, and then as the screen was nearer or farther lines of light in 2 or even 4 directions appeared (constant). This was exceedingly beautiful and easily rendered visible to a large Audience.



74. On making expts. on the reflection of waves from the edges of Young's table at present I found a feeble wave was reflected. On putting strips of calico in the water round the edge it was still further diminished. On putting saw dust (tow?) all round the edge it was apparently quite destroyed, but the effects took place as before, and in this as in many other expts. is shewn to have no particular influence in *causing* the heaps.

75. With respect to such portions of fluid as were used on the glass plate, but little reflection took place from the edges of water when raised by capillary attraction or depressed by it, but did by an obstacle equal in height to the surface of the water.

76. The round plate on feet was covered with water beyond the nodal line and vibrated by the glass rod: the crispations formed sometimes quadrangular but more frequently irregular, but they could always be sustained until they ran into the quadrangular. Here no return waves could exist because the water was quiescent at the circular nodal line.



77. An air pump jar was covered with parchment and set as in the figure. Water was poured on to wet the whole of parchment, a piece of cork put in the middle, the rod rested on that and the parchment vibrated: the water formed a little lake in the middle passing gradually into mere moistened surface. Yet the crispations occurred, though irregularly; yet no return of waves could

exist here. Some portions of the crispations where there was least water were quadrangular.

78. The heaps were of the same size laterally on large and on small plate vibrating same number of times when depth of water was sensibly the same.

79. Can easily modify place where heaps originate: thus with equal depths they commence at place of greatest motion, but by increasing depth in one part may make them commence there though not the place of greatest motion.

80. The maxima and minima of height for the heaps appeared to be alternately almost immediately after the supporting plate had begun to descend in the course of one complete vibration.

81. Pieces of cork move about irregularly on the surface of large heaps as lycopodium does on small ones.

JUNE 30TH, 1831.

82. Had a plate of tin circular about 10 inches in diameter and dished about $\frac{1}{8}$ of an inch—moistened it first with alkali to wet it, then put water in so as to make sufficient depth at middle but passing gradually into mere moistened surface—crispations formed well at middle but were not constantly quadrangular, they shifted continually. Here no return waves.

83. Obtained fine large heaps on this plate.

84. By putting ink on this plate, then the light and dark chequers and the alternation was beautifully exhibited, better than by glass plate and white paper beneath.

85. Then used a mercury bath. A piece of tin plate about $2\frac{1}{2}$ inches square was fixed on cross bar, floated with mercury and vibrated. The crispations formed with extreme rapidity and very beautifully; they were smaller than with water having same vibration. The Mercury soon became filmed, but on clearing of that with a piece of paper, the clean crispations again occurred, but mercury soon became filmy and so on. Very filmy mercury caused irregularly arranged crispations, large and small, etc. etc., but a little acidulated water being on the mercury prevented all film and then crispations very equal and beautifully regular—quadrangular—and the lines of heaps parallel to the diagonals of the plates nearly always.



86. When the mercury was dry and clean and when after one or two vibrations but little film had formed, then it often remained on the mercury in lines, marking out the previous positions of the pimples. On looking in one light, lines could be seen coinciding with the intervals of the pimples in one direction, in another light the cross lines coinciding with the other direction came into sight and the first disappeared, and in a third light both sets of lines were seen cutting out the square places where the dimples had existed. Here the film was minutely wrinkled and bagged as if it had been most distended. At the cross lines it was not so much wrinkled, and at the crossing of the lines themselves it seemed quite free from mark and fully distended. All this can be understood by considering the film as a flexible but not elastic envelope which had formed over the whole surface whilst the pimples were rising and falling.

87. When much film was on the mercury and was drawn into streaks the dimples or ripples formed under and in accordance with these streaks; the tension of the enveloping film being able to give direction to the forces emanating from the plate.

88. Mercury in drops on the table, or mercury in basins, glasses, etc. standing on the table—vibrated and exhibited lines, circular principally, resulting from the communicated motion.

89. When Ink was put on the mercury on the plate some beautiful appearances were seen. The mercury now when forming dimples could be seen sending up the dimples through the ink, and by rendering the latter thinner there shewed the arrangement of forms beautifully. The arrangement was now beautifully regular (the ink acid having dissolved all film) and constantly quadrilateral, the lines being parallel to the diagonals of the plates. The form of the sides of the plates had in these cases determined the arrangements (not originated them). These peeps of the pimples were very beautiful. The optical effect is the reverse of that when ink pimples were formed on tin plate. As oil does not form dimples readily, black oil would be good for this experiment.

90. The determination also of substances to the centers of vibration were well seen here, for though when quiescent the ink covered the mercury uniformly, yet when vibrated, as the mercury was more abundant in one part than another the waves formed

there first caused the thinning and gradual dissipation of the ink to the other parts, that being left for the moment quite clear: on ceasing the motion the ink returned. This appears to be due to the relative gravity of the mercury and ink and is analogous to the whirling table effect: the heavier substance receives the greatest centrifugal force.

91. Saw last night a Brewer's caravan going along over the stones. It contained empty Butts upon end and rain had fallen on to them. As the vehicle proceeded it rumbled over the stones and the upwards jerks frequently threw the water up into heaps quite of the nature of the crispations.

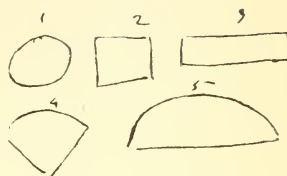
92. Several pieces of glass of different shapes were put on the cross bar, covered with water and vibrated. In all the arrangement tended to become quadrangular: in 1, 2 and 3 it was readily obtained and nearly constant, in 2 and 3 the lines of heaps were mostly at angles of 45° to the sides. With 4 and 5 the arrangement was more irregularly and started off in different manners. The form of the plate and of the edges of the pool evidently have much influence in determining the final arrangement.

93. Some small print, net and an engraved tint were put against the under side of a glass plate on which large heaps were then induced, but nothing particular occurred.

94. A largish plate was arranged on the cross bar with such intervals as to give large vibrations and then covered with sand $\frac{1}{8}$ of inch deep. With weak vibrations the sand was dispersed and nothing particular occurred; but with strong vibrations the sand formed arrangements in the air apparently as if it produced a net work, for there were comparatively free holes through which the glass could be seen with little or no sand there. The effect is very curious, and by having a plate with raised sides to keep the sand on may probably be continued a long time.

95. When the sand was put into a basin the same effect was shewn.

96. When a single heap of sand was formed it involved something like lycopodium in air, the whole flying off fast however from the outside; but the theory appeared to be of the same kind. In the reticulated appearance I think it seems as if the sand rose at the places w[h]ere it forms net, and that air descends by the freer



spaces. I speak generally; of course many grains of sand fly in all directions.

97. When Much lycopodium is put upon large stretched paper and struck up violently in the air, it often forms clouds in lines or masses involving.

JULY 1, 1831.

98. Mercury on tin plate being vibrated in sunshine gave very beautiful effects of reflection. These might be transmitted on to a screen, but the focal lengths of the cavities were usually too short to allow of screen being placed at convenient distance. Perhaps a concave lens might make this a beautiful Lecture room Expt.

99. The travelling of the sun's image on each point was very beautiful and satisfactory.

100. It was pretty to see the reflection on the ceiling disappear as the vibration was induced.

101. Ink and water vibrated in sunshine looked extremely beautiful.

102. Dr. Brewster with me to-day. I shewed him some of the Experiments.

103. Have obtained some long and regular lathes, and also bridges from Mr. Royce. They answer very well indeed. Can now easily do with them all that was done with the plank and Young's table. Got very large heaps on them.

104. Alcohol vibrates very well; so also Alcohol and Camphor.

105. Oil of turpentine vibrates and forms very well.

106. Oil of turpentine and water on same plate in mingled patches. Map-like. Vibrations and forms accord very well, running off one on to the other without much confusion at the confines of each. There was a little confusion owing to difference of cohesion, etc. etc.

107. Have had a tin plate circular and 6 inches in diameter dished slightly. Being amalgamated and put on a vibrating bar, mercury was poured in: it formed a pool at the center gradually diminishing to the sides. Upon vibrating it several natural and satisfactory phenomena took place. The mercury flowed from the center and passed a good way up the side, and when vibration stopped it returned to original depth at middle. It did not recede altogether from middle but diminished there and increased at sides w[h]ere



before there was very little. As whole of plate suffered equal vibration, i.e. possd. equal vibrating force, this is a natural effect of lateral communication by the waves from center to sides, and is opposed to the notion that waves originating the pimples *commence* at sides.

108. Then on observing crispation it was found to be very regular and quadrangular at the middle where there was plenty of mercury, etc.; but then passed into concentric waves nearer to the edges and there was a large portion of surface covered with concentric waves. These could not originate the quadrangular crispations. Their cause was merely the deficiency of mercury and the direction in which the mercury thinned off.

109. These effects took place as well and better when the exciting glass rod rested not in the mercury but on the wood at one side. It did not at all interfere with regularity of vibrations, any more than the violin bow does applied not at middle but near one end of a string.

110. By varying the position of the exciting rod the cross bar could be made to vibrate in aliquot parts, producing higher notes and quicker vibrations, and then crispations of mercury became smaller corresponding thereto.

111. Then resumed expts. with sand. Have a tin plate 4 inches in diameter with round edge $\frac{3}{4}$ of inch high, this fixed on bar to vibrate. The white glass maker's sand in it gave very good effects. The sand when vibrating seemed to form a reticulated texture, there being apertures through (perhaps $\frac{1}{4}$ to $\frac{1}{8}$ of inch wide), through which tin bottom could be seen. It looked like a honey comb arrangement of cells perhaps $\frac{3}{4}$ of inch deep but shifting continually. The size of cells were large with more forcible vibration; some with moderate vibration were very small and beautiful and often seemed to be in a quadrangular arrangement, but forms continually and rapidly shifted. There should not be too much or too little sand. On suddenly ceasing vibration sand settled occasionally in forms corresponding to the appearance whilst vibrating, but as it rebounded of course it settled usually all over the plate, being only thicker or thinner in different parts. A side light by throwing shadows shewed the forms best.

112. When plate not accurately arranged sand would accumulate



at this or that side and then formed with weak vibration involving heaps like lycopodium, but large. These could with increasing vibration be traced into the cellular walls, and I believe at present that the walls are of sand rising through the air and the cells passages by which air is passing down towards plate—analagous in action indeed to lycopodium heaps except that perhaps much air is carried upwards with sand at those places.

113. Tried several other kinds of substance, Magnesia, etc. but not do well. James Powder shewed effect but not very well—red lead—red oxide of iron—feebly.

113a. The sand mingled with a little red lead or red oxide of iron to colour it showed effects very well. They were very pretty and were regular when soft vibrations of a two foot lath were used.

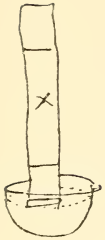
114. Then used a longer lath and of course slower vibration. Phenomenon very striking and evident.

115. Now vibrated water but used a basin and had some depth—still vibrations took place. Used a finger basin and had 3 or 4 inches deep of water: plenty of undulation of the true or present kind—depth in fact no barrier, for effects still occur, of course at the surface.

116. Put mercury into the finger basin under the water, then both became pimpled, the mercury very beautifully as seen through the sides of the basin. Probably by putting sand round edge of the mercury very effectually destroy lateral vibration or returned vibrations.

117. Now went to vibration of plate in another direction to the water. Put a plate upright against bridges, a basin of water beneath so that end dipped into it a little, and then vibrated the plate by a glass rod at x or by tapping with finger.

118. Elevations, waves or crispations immediately formed but of a peculiar character. Those passing off from the surface of the plate over the water to the sides of the basin were hardly sensible, but apparently permanent elevations formed, beginning at the plate and projecting directly out from it to the extent of $\frac{1}{3}$ or $\frac{1}{2}$ an inch or more, like the teeth of a very short coarse comb. These varied in their commencing at the glass; or having intervening ones; or in height; or in length; or in number; or in breaking



up into violently agitated pimples, etc. etc. according as the plate dipped more or less into the water; or vibrated more or less violently; or sub-divided whilst vibrating into parts. But when plate was only about $\frac{1}{6}$ of inch immersed (being one about 16 or 17 inches long), then 4 of these permanent ripples occupied as nearly as possible the same space with 4 heaps formed with the same plate and note in the ordinary way. The experiment shews at once the cause of the ripple or crispation formed at surface of water in a drinking glass vibrating under the finger.

119. The water arranged itself in those heaps (alternating probably) as compensate most readily for the displacement of plate. It is a beautiful proof that crispation does not arise from opposing or crossing waves, for they are here at right angles to any such.

JULY 2ND.

120. Procured a very large glass (a glass jar will do), filled it nearly with water. Then with wet finger at edge brought out tones—there was crispation of surface—this was divided into four divisions; the finger, the opposite part and the two at right angles $\times \times \times \times$ were places where the crispations were weakest, but the intervening parts $\wedge \vee$ were places where they were strongest. At the former they were little ridges *apparently* permanent standing out along the surface of the water perpendicular to the glass: at the other places they were breaking into confused heap like crispations. By diminish. the force of vibration the former almost entirely disappeared and the latter became simple linear heaps perpendicular to the glass. *Very good.*



121. Made a plate vibrate yesterday immediately over the surface of water yesterday, but obtained no effects.

122. Used a tuning fork and glass of water for the ridges. If fork vibrate too hard then violent agitation and drops thrown off. If too feebly then only the waves outwards, and which between the two limbs of the fork produce ordinary stationary undulations; but if with moderate force then the stationary ridges at right angles to the intersecting line of the water and fork appear very prettily, and often so strong as to overcome the ordinary stationary undulations between the two limbs.

123. If the fork be inclined still the ridges occur all round the



touching part, and when fork held almost flat still ridges very good alway round. Ought to happen, for as fork occupies more or less room in the water the water has to vibrate in alternate heaps to compensate for change of volume.

124. From this many conclusions flow. Cylinder little immersed and vibrating up and down ought to produce them. If much immersed ought not because whole mass of water not moved so rapidly. So also if but little immersed much sound ought not to be conducted, but if much immersed fluid ought to conduct as well as some solids. Try all these—afford easy mode of effecting phonic communication, etc. etc. etc. etc. An instrument to measure liquidity of fluids, etc. etc.

JULY 5, 1831.

125. Continued the Experiments with the tuning forks and fluids. The limb of the fork put into ink shewed the effects very well.

126. The limb of the fork put into mercury shewed the ridges also, but the vibration of the fork was very rapidly stopped from the density of the mercury.

127. When the butt end of the vibrating fork was put into mercury in a basin, very minute undulations were observed upon the clean surface, but they were of the nature of ordinary stationary undulations.



128. When limb of fork was put upright in cold oil, no ridges were observed. When put in very obliquely, the vibration being strong, four currents rising up from under the fork into the air $\frac{1}{2}$ inch high or more, to the right, to the left, forward and backward, were produced. These were actual fountains, but soon ceased as the force of vibration diminished. They depended upon the determination of these four currents by the mechanical action of the limb acting as a pump piston and the cohesion of the fluid. No ridges were formed.

129. Upon putting a spirit lamp under the oil, so soon as it was somewhat warmed these streams diminished a little and became ultimately splashing as with water, and the peculiar ridges appeared, the oil having now lost that tenacity which it previously had.

130. When the fork placed obliquely is, from its strong vibration, splashing the warm oil, the shower of independant oil

globules formed is very beautiful; they float for some time on the oil beneath.

131. On putting a wire into a tube of water and bringing the end of the vibrating tuning fork to the wire nothing particular was perceived as to the difference of conduction of sound, etc. by more or less depth.

132. Very thin jelly, so thin as to flow, did not shew crispations of glass plate well. Jelly in this state is more like oil than white of Egg. It is very sluggish.

133. On returning to the experiments upon sand under strong vibration forming honey comb appearance. Very minute shot shewed effects, so also did millet seed, but neither so well as sand. Lycopodium added to the sand shewed nothing particularly.

134. The large drawing paper screen was put horizontally, much sand put upon it, and then the paper struck up from beneath. The peculiar appearances of the sand were visible but not better than in tin plate with round edges. It was however evident that the sand rose up highest and in largest masses from those parts where it had fallen in largest portions, and the tendency is not to equal diffusion but rather to concentration in these heaps.

135. The involving effect (which in fact is a weaker exhibition of that just mentioned) was beautifully shewn. When the paper was covered with sand a few blows upon the edges or other parts caused it to draw up into patches linear or insulated according to various circumstances, all of which involved beautifully and very sensible at a distance. When sifted regularly over, the manner in which the sand drew together in little heaps was very beautiful.

136. The sand being cleared off, much lycopodium was put on. Here the involving effects were also very beautiful. But with reference to the arrangement of the lycopodium in the air when struck up forcibly from below, forming that peculiar tessellated or reticulated appearance, it appears to be of the same nature as the form given by sand and to depend upon more forcible impetus in one part than another and a consequent periodical or intervening reaction of the air.

137. As before stated water in a finger basin of much depth forms surface of heaps when vibrated on the lathe. When surface covered half an inch with oil, the oil also forms heaps, but these are smoother

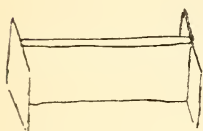
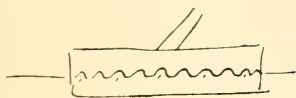


than those with water and, though requiring more force to produce them, perhaps shew the conical form of each heap better from the tenacity of the oil. The cones are easily kept up and are very good and regular.

138. Now went to experiments upon the lateral vibrations of bars and plates in water.

139. A wooden lath was fixed with one end in a vice and the other descended into a vessel of water. On vibrating the bar by means of a glass rod and wet fingers very large and good ridges were formed. As the rod dipped further into the water the vibrations were slower and the ridges larger and fewer. When vibrations were very violent the ridges often were mechanically broken and dispersed in drops. When lath was made to sub-divide by application of glass rod nearer the vice the ridges were more numerous and smaller.

140. A large cross piece of board was fixed to the end of the lath so as to produce a larger vibrating surface in the water. The board might be 7 inches by 3 inches and the lath $\frac{1}{2}$ inch thick, $1\frac{1}{2}$ wide and from 2 feet downwards in length. Many more ridges were now obtained at regular intervals starting out from the board, and now it was ascertained that there were two sets just as of the pimples and that when one set was down another was up; thus all of this mark $\sim \sim$ were up at once and when they went down all those $\sim \sim$ came up. For each to and from motion or one complete vibration one of the sets appeared, so that in two complete vibrations the cycle of changes was complete. As the ends of the board were open and the vessel of water was not very large certain disturbances of the water took place, preventing a conclusion respecting the existence of currents or not. To avoid this another piece of board, about 8 inches long and four inches deep had pieces of tin plate above 4 inches by 5 inches fixed on at the ends so as to cut off much of the lateral motion, and then this being fixed at the end of the lath was vibrated in the water. When deep the vibrations were slow and ridges large. When immersed but an inch the vibrations were quicker and ridges smaller; they were very regular and did not form except on the wood and parallel to the course of its vibrations. Pieces of cork and lycopodium powder shewed that there was no important current setting in the

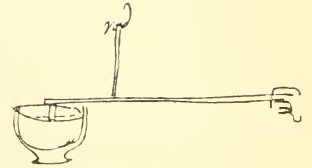


direction of the ridges—cork close up towards the wood, i.e. at the head of the ridges, oscillated to and fro from one ridge towards its neighbour just as they do from one heap to another in the ordinary phenomena. The lycopodium sometimes moved or seemed to move on the ridges from the wood and between the ridges to it, but it was very irregular and there was no current setting into or out from the wood generally, nor was the disturbance so much as with lycopodium on water amongst the heaps. The ridges are evidently reciprocating ridges. They exist on both sides the wood but do not seem necessarily to correspond, for they frequently shifted a little so as to coincide or not quite accidentally.

141. A very simple arrangement shewed this [these] ripples with extreme beauty. An oval foot bath being nearly filled with water, a piece of lath such as described above was held with the two ends against the curved sides so that the lath was partly immersed and then vibrated horizontally by the glass rod and wet fingers. The ripples instantly appeared on both sides, were an inch in length, more or less numerous according to the length of the bar, the part immersed, etc. and could be well shewn by a light passed through it. Even when the top of the lath was nearly an inch under water the ripples could be made to form over it at the surface.

142. Glass plates and metal plates are easily vibrated in the same way.

143. Now went to perpendicular action. A cork was fixed by cement near the end of a lath and the latter fixed by the other end in a vice, the cork being downwards: then the rod of glass being applied and the fingers used the lath vibrated carrying the cork, and a basin of water was brought up to the latter. So soon as the cork touched the water a beautiful store of ridges formed all round it, running out 2, 3 or even 4 inches. These were more or less numerous according to number of vibrations, etc. etc. and force of vibration. On raising the water so as to immerse more of the cork the ridges soon diminished in elevation and strength and by further immersion disappeared: thus when only $\frac{1}{2}$ an inch deep, strong vibration was required to produce them, but when only touching the surface they were beautifully formed with the least force. By moving the glass rod so as to make the lath



subdivide in its vibrations, corresponding alterations in the ripples were obtained.

144. Arranged the large glass plate and long lath for large vibration. It will very well with care, etc. etc.

145. Made a few experiments on the action of oil and oil of turpentine in stilling waves but did not satisfy myself. Must experiment on Ponds, etc.

JULY 18, AT HASTINGS.

146. Remarkd a peculiar series of ridges produced by action of steady strong wind on water on sandy shore. Wherever the sand was covered by a layer of water too thin to form waves before the wind, yet flowing over the surface as where it was oozing out from above, slight ridges were formed *parallel to the direction of the wind*. These would be two, three, four or more inches long and were continually reciprocating, i.e. ascending and descending in succession: the eye could trace the two series of resulting waves which seemed to travel from right to left and left to right over them. Of course these opposing waves were the *consequence* not the cause. The sun's image was a good object to render these ridges visible. They were not high, but high enough to arrange the sand beneath, which was left lined in this way parallel to the wind's course over very extensive flats. The ridges covered all the wet sand, and also appeared in the pools when the windward edge was flat and before waves had formed. When the water deepened enough to form waves then these ridges disappeared. They are small and require carefull looking for, but being once seen they are easily found again. They may serve to indicate how the wind has been during a night, etc. etc. for they are perfectly parallel to its course.

147. I could not get them on a plate or on a stool. The wind must be of equable force and sweep the surface undisturbed by any projection or irregularities which cause eddys, hence the advantage of the sands.

Repeated fig. 7¹ arrangement, nearly quadrangular marking, not one double the other but numbers as 7.5 one way and

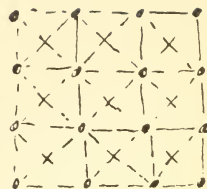
¹ The fig. 7 (23) at foot of page 329 is apparently referred to here.

10 at angles of 45° to former, counting the heaps in an equal length.

Vibrated round plate on lath with water and sand so as to obtain circles and then square arrangement; the numbers of intervals between the circles and between the heaps were the same for the same plate, water, vibration, etc. etc.

Vibrated plate for luminous image; was as in the margin.

Examined light reflected from top of each heap: varies very much with position of candle, age, etc. etc. etc.



CRYSTALS, SURFACE OF

20TH MARCH, 1832.

Have selected some crystals of Carb. soda, put them in basins, put a solution of the same carbonate over them, and covered them over with paper to evaporate and crystallize—hoping for large masses of crystals but with natural surfaces.

Some of the pieces were a little effloresced when put in; others clear of efflorescence. I do not know whether the effloresced part will become the most or fully hydrated. I fear not.

APRIL 5TH, 1832.

To-day opened the basins. The solution had crept up to the covering paper and crystallized there. Took paper off, found all beneath dry and crystals very fair and transparent, with good surfaces except here and there a little dullness from the old effloresced part. Cleared away the film of carbonate from the edges and sides of the basins, which of course left a crushed or broken edge all round, but thin, and then recovered them with fresh paper and left them again (2, 3, 4). The crystals of one basin became loose and were transferred to another, I hope without crushing or breaking any part of the surface (5).

AUG. 1, 1832.

A basin of crystals of carb. soda of date *Sept. 5, 1827* (1) still uneffloresced in any part.

The undisturbed basin of April 5 (2) same as then. No efflores.

The do. do. (3) also the same.

The do. do. (4) altered a little at edges of film and here and there at angular dull parts of the solid crystals, but not much.

The transferred basin (5) specked a little with efflorescence especially at angles.

A basin of sol. glauber put by on April 1832. Is now completely crystallized but *no signs* of efflorescence.

Phosphate of soda probably the same.

Sul. Soda crystals.

Looked at Basins of crystals.

No. 1. Still uneffloresced except a little at the very edges of mass.

No. 2. Still uneffloresced.

No. 3. Little efflorescence at end of one crystals and a spot or two on the other.

No. 4. Not much extension of efflorescence. Now nearly as 3.

No. 5. Specked more than before.

No. 6. Glauber not effloresced any where.

No. 7. Phosphate of Soda. Fresh moist crystals put away on the 3rd August, 1832 are now perfect. No efflorescence except that at edges of moist places, and here and there on single crystals are little elevated white portions like globes and these are probably not efflorescent parts but minute crystals grouped by capillary attraction, etc. etc.

No. 8. Phosphate of soda. Fresh moist crystals put away on Aug. 3, 1832. Clear and transparent, no efflorescence, a little trace on basin of whiteness at edge of the moistened part.

No. 9. Phosphate Soda. Part crystals part solution put away Aug. 4th, 1832. Now all is dry, crystals very beautiful and clear and no appearance of efflorescence. Many of the crystals are long prisms.

No. 10. Phosphate of Soda. Crystals and solution put aside together on Aug. 4th, 1832. Now all dry and crystals clear and not effloresced. Many of them are long prisms. Round the mass the thin film of salt has risen up here and there from the basin and seems white as if effloresced, but it may perhaps be only a congeries of minute crystals. Time will shew.

Influence of Mechanical arrangement over chemical affinity. Is not introduction of wire or nucleus, solid, into saturated cold solutions or cooled acetic acid the same principles more highly exalted?

And then is not that the same as action of spongy platina on oxygen and hydrogen. If either gas alone were put up into spongy platina would there not be condensation?

Are not all these phenomena results of one cause?

Make crystals of salts with wires, etc. in them. Put spongy platina into gases which are required to combine and subject all to sunshine.

No. 1 as on Aug. 30th except that efflorescence farther in towards middle.

No. 2 quite unchanged.

No. 3 efflorescence extending, above half surface covered.

No. 4 efflorescence proceeding—but not much yet.

No. 5 do. do. over part of surface planes.

No. 6 Not effloresced any where.

No. 7 Exactly as before—beautiful.

No. 8 do. do.

No. 9 do. do.

No. 10 do. do.

3 DEC. 1833.

1. All effloresced.

2. do. , the paper hard from imbibed salt.

3. do. on surface, parts within still transparent.

4. As 3.

5. As 3.

6. Not effloresced any where as yet.

7)
8 } All effloresced; parts beneath here and there transparent.
9
10)

LIME EXPERIMENTS AND C. A.

1832. MARCH.

About 4 or 6 months ago Brunel (Junr.) wanted to make carbonic acid by heating carb. lime in close vessels, but though he gave great and long heat could get no gas over.

He and Hawes (Wm.) came to me about it. I remembered certain similar effects with myself, and also Dr. Wollaston's directions to me for making quick lime, and suspected that heat alone was hardly sufficient to cause the decomposition. I recommended Brunel to send vapour of water through; this he did, and then obtained plenty of carbonic acid gas and caustic lime.

Dr Wollaston's directions to me were, when I wanted perfectly caustic lime, to slake the lime once calcined and then to re-calcine it. It would be perfectly caustic the second time.

I think Phillips (R.) mentioned some results of the long calcination of chalk some time since by a friend of his, but I do not remember whether it did not become caustic or whether it became hydraulic cement.

Berthier's expts. on fusion of carbonates, etc. interesting. He says he easily fused mixed single proportionals of Carbonate of lime and carbonate of Soda, also 1 : 2. Quar. Journ. xxvi, 436, or Annales de Chimie, xxxviii, 246.

Berzelius has remarked and described the fusion of dry carb. lime, the effect of water, air, etc. etc. very well. French Edition Vol. ii, p. 358. I cannot admit the explanation however.

Hall's expts. seem very doubtful to me, i.e. I have never yet seen good crystals and I doubt whether the pressure in the experiments was of any consequence.

1832. MARCH 15TH.

Dried carbonic acid gas over S. A. Put dry carb. lime (whitening) into a platina tube, connected it with the Dry C. A., allowed a little to leak over the carb. lime and escape at the end of tube and heated the tube by an oxy-alcohol lime—thus the carb. lime

was exposed at very high temperature to dry carb. acid. After a few minutes examd. it. The substance was harder, contained very much C. A. and very little free lime.

Repeated expt. continuing the heat longer and at one place. On removing the matter one piece was now very hard, contained much lime and but little carb. lime. It was not fused. Thus heat does drive off carb. acid though with great difficulty.

On heating some carb. lime in same tube by common blow pipe but putting a little water into the tube then the lime quickly became very caustic.

Volcanic marble—appearance of fusion though not under pressure.

MARCH 16TH.

Heated carb. baryta native in tube with steam passing. On putting it in water no trace of caustic baryta—all was still carbonate—used only oil blow pipe lamp for the purpose.

Put dry caustic lime into dry carbonic acid gas over mercury; marked place of gas and left it for 24 hours. No change in place.

MARCH 17TH.

Then moistened a little piece of paper, 1 inch square, rolled it up into a pellet and put it through the mercury into the jar. Left all for 48 hours.

MAR. 19.

Then the mercury had risen much—all had passed into the jar—air had entered and upon letting in water and agitating I found very little carbonic acid gas was left. Hence distrust fact no absorption between dry lime and carbonic acid—but little water immediately brings it about.

Sir Jas. Hall's expts. on heat and compression. Edin. Phil. Trans. for 1812. i.e. Vol. vi, p. 71.

Deposits from Mr Babbage from Temple of Serapis, Piscina mirabili and Temple of Mercury. Baia and near Naples.

Temple of Serapis. A thin hard brown crust, consisting of numerous successive layers—very distinct and indicative of deposition, the flattest inside surface more crystalline than the outer surface. Looks very like a fur—or a calcareous deposit.

Boiled in water gave a very weak solution of Sul. lime.

In M. A. great effervescence, little smell like that of bituminous limestone—the deposit being in excess a neutral solution was obtained and with the excess was left peroxide of Iron a little. The solution with Amm. gave scarcely any precip.—by carb. amm. much of Carb. lime. It contained a little S. A.—Magnesia I could find none. On boiling the undissolved residue in more M. A. (in excess)—left a little siliceous matter, and oxide of iron was taken up. Alumina, no sensible trace.

Substance is a deposit principally of carbonate of lime. There is a little Sul. lime and a little silica, Iron and perhaps alumina. There is no magnesia and no sensible trace of a muriate. These rather against notion of *sea deposition*.

Piscina Mirabili. A hard brownish earthy mass, external surface tuberculated, rough and stalactitical—appearance of layers far less evident but occurring here and there—whole more crystalline than former—is very like a carb. lime deposit.

Boiled in water gave a weak solution of Sul. lime—no sensible trace of muriate.

In M. A. great effervescence—little smell as before of bituminous limestone—the deposit being in excess a neutral solution was obtained, and with the excess was left a little peroxide of Iron. The solution with ammonia gave scarcely any precipitate; with carb. ammonia much of carb. lime. There was a little Sul. acid present but no Magnesia. On boiling the undissolved portion in more M. A. a solution containing iron was obtained—no alumina, and a little silica was left.

This substance is a deposit like the last consisting of Carb. lime with very little Sul. lime, Silica, oxide of iron and perhaps alumina, but no muriate or magnesia.

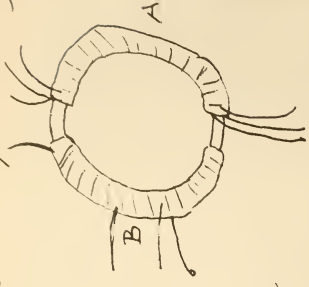
Temple of Mercury. This piece very rough and irregular—very tuberculated outside and white as snow there, also highly

crystalline; towards the other surface a little brown but crystalline.

Does not effervesce with M. A. Is soft in the mortar. Boiled in water gave a sat. solution of Sul. lime—not a trace scarcely of M. A.—no other earth or base.

Boiled in M. A. all dissolved but little siliceous matter and oxide of iron—a little oxide of iron dissolved. The rest sulphate of lime. The deposit is essentially sulphate of lime.

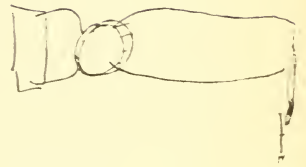
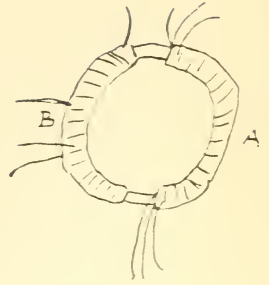
make from the other will call this side of the ring
 A. on the other side but separated by an
 interval was wound wire in two pieces
 together amounting to about 60 feet in
 length the direction being as with the former
 coils this side call B.



3 Charged a battery of 16 pairs plates eaches approx. Made
 the coil on B side one end and connected its other end by
 a copper wire passing to a distance, and put over a magnet
 north (3 feet from wire ring). Then connected the end of one of the
 pieces on A side with battery, immediately a visible effect in motion
 of magnets of metal at last in original position. On breaking
 connection of A side with Battery again a disturbance
 of the metal

AUG. 29TH, 1831.

1. Expts. on the production of Electricity from Magnetism, etc. etc.
2. Have had an iron ring made (soft iron), iron round and $\frac{7}{8}$ inches thick and ring 6 inches in external diameter. Wound many coils of copper wire round one half, the coils being separated by twine and calico—there were 3 lengths of wire each about 24 feet long and they could be connected as one length or used as separate lengths. By trial with a trough each was insulated from the other. Will call this side of the ring A. On the other side but separated by an interval was wound wire in two pieces together amounting to about 60 feet in length, the direction being as with the former coils; this side call B.
3. Charged a battery of 10 pr. plates 4 inches square. Made the coil on B side one coil and connected its extremities by a copper wire passing to a distance and just over a magnetic needle (3 feet from iron ring). Then connected the ends of one of the pieces on A side with battery; immediately a sensible effect on needle. It oscillated and settled at last in original position. On *breaking* connection of A side with Battery again a disturbance of the needle.
4. Made all the wires on A side one coil and sent current from battery through the whole. Effect on needle much stronger than before.
5. The effect on the needle then but a very small part of that which the wire communicating directly with the battery could produce.
6. Changed the simple wire from B side for one carrying a flat helix and put the helix in the plane of the Mag. Meridian to the west of the S pole of the needle, so as to shew best its influence when a current passed through it—the helix and needle were about 3 feet from the iron ring and the ring about a foot from the battery.
7. When all was ready, the moment the battery was communicated with both ends of wire at A side, the helix strongly *attracted* the needle; after a few vibrations it came to a state of rest in its original and natural position; and then on *breaking* the battery connection the needle was as strongly *repelled*, and after a few oscillations came to rest in the same place as before.



8. Hence effect evident but transient; but its recurrence on breaking the connection shews an equilibrium somewhere that must be capable of being rendered more distinct.

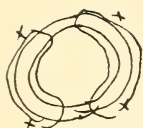
9. The direction of the pole towards the helix was, when the contact was first made, as if the helix round B was a part of that at A, i.e. the electric currents in both were in the same direction; but when the contact with the battery was broken the motion of the needle was as if a current in the opposite direction existed for a moment.

10. Had a short cylinder of iron $\frac{7}{8}$ thick, 4 inches long, and coiled round with 4 pieces of wire each about 14 feet long: made these coils into one and substituted this in place of the flat helix. The needle was affected as before, but not at all as if the iron had helped to develop magnetic power—not more than helices round it would probably have done without the iron. It was the same transient and inverted states as before.

11. Removed the iron and helices and substituted two platina poles to ends of B coil; put these into solution of copper, lead, etc. etc., but could get no evidence of chemical action. Put solution of copper on to one pole and then touched the drop with the other; then connected the battery, then broke connection at drop, and then at battery, and so went on in succession so as to avoid the recurrence of the return or opposite current on the drop: but got no evidence of chemical action.

12. On making *all* the wire round the iron ring one helix and sending current from battery through it, and also hanging a magnetic needle over the ring, one pole being in the middle at the point of suspension, the needle darted about irregularly and shewed poles—two N and two S. On putting paper over the ring and sprinkling filings over it also see the 4 poles, but were irregularly placed. Iron probably not soft but evidently not a perfect conductor, for the parts between the ends of the two general helices of A and B were of very different magnetic power to the ends of the helices.

13. Put a helix (of brass brace spring) round a glass jar and brought a needle within it in various positions, but it behaved merely as a single ring of wire would have done.



14. Repeated (6): continued the contact of A side with battery but broke and closed alternately contact of B side with flat helix. No effect at such times on the needle—depends upon the change at battery side. Hence is no permanent or peculiar state of wire from B but effect due to a wave of electricity caused at moments of breaking and completing contacts at A side.

15. Tried to perceive a spark with charcoal at flat helix junction B side but could find none. Wave apparently very short and sudden. No use trying platina wire. Not sure large battery would not produce spark.

15a. Then disjoined the three portions of wire on A side—made two into one helix and sent battery current through that—and connected the third portion with the flat spiral and needle, etc. so as to represent B side. Effects on needle stronger than before but same in character, occurring inversely, etc. on breaking battery connection, etc. etc.

16. A large bar magnet brought in contact with the ring caused no change at the flat helix.

17. May not these transient effects be connected with causes of difference between power of metals in rest and in motion in Arago's expts.?

18. Took the iron cylinder (10) and connecting two of the wires into one Helix and the other two into another, connected one of these Helices with the flat spiral and needle and the other with the battery—immediately a sharp short pull upon the needle, the effects being exactly as before but not so strong. Hence a ring magnet is not wanted.

19. Brought the poles of strong magnets in contact with ends of the iron cylinder, but found no difference upon the needle at the flat spiral—all the effects seem due to the Electrical current only.

SEPT. 12, 1831.

20. Have prepared several coils, helices, etc. etc. Coil A consists of various lengths (as under) of copper wire, string being interposed between the turns of each coil and calico or linen between the different coils.

Coil B was composed of alternate copper and iron (see lengths

beneath), the iron either covered with cotton or else separated as before.

A	B
20—6	C—26—6
20—5	I—30—6
21—4	C—31—5
24—3	I—31—5
25—2	C—36—4
26—1	I—38—4
27—6	C—38—3
28—5	I—37—3
28—4	C—39—2
29—3	I—37—2
31—2	C—38—1
31—1	I—41—1
<u>310</u>	<u>422</u>
	C—208
	I—214

These lengths are the lengths of coil (not including the projecting ends), and the core in each is of wood.

C a flat spiral of covered iron wire containing about 6 feet.

D a double flat do. do. 19 feet.

E a do. copper wire uncovered do. 14 feet.

F a cylindrical round solid helix of covered iron wire containing about 12 feet.

G do. of 31 feet.

H a double flat spiral of covered iron wire of 18 feet.

I a coil of covered iron wire 35 feet about and $2\frac{1}{2}$ inches mean diameter, forming a thick ring; this then covered by a helix at right angles to it of two lengths of copper wire 40 feet each or 80 feet together, these being separated by string and calico from each other as in former cases.

K The iron ring covered of (2).

L The covered iron cylinder of (10).

SEPT. 24, 1831.

21. A tried—each length independant and right—half the lengths (i.e. 1, 3, 5, 7, 9, 11) made into one helix, the other half (i.e. 2, 4, 6, 8, 10, 12) into another helix by connection, so as to form two helices closely interposed, having the same direction, not touching anywhere and each 150 feet long. One helix connected

as in (6) with flat helix and the other with battery of 10 pr. plates 4 inches square. Not the slightest effect on needle at flat helix either at time of contact or disunion or any other way. No induction sensible—contacts all perfect.

22. Then B, the final copper helix containing 208 feet wire, the final Iron helix 214 feet, but no effect on needle, though sometimes the battery current was sent through the iron, sometimes the copper; the iron seemed to do no more than the copper.

23. Used H. When brought towards pole of needle concentric with it, the pole seemed to be repelled towards edge in any direction going from $+$. In fact the pole of needle in inducing magnetism on the wire could do it better at a than at $+$, and better at b than at a , opposite poles no doubt being formed at c or d . Would be it so also with a continuous plate as well as a flat helix. Evident therefore that magnetic action tends to arrange particles longitudinally in the direction of its own axis and is itself powerfully arranged by previous arrangement of iron particles—important influence thus exerted.

24. When H connected with the battery then the centers were the poles, and there was nothing particular in the magnetic action evolved. The moment the connection was broken the magnetism was lost.

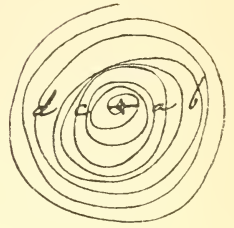
25. The double flat iron helix H connected with wires leading away, as in (6), to flat copper helix and needle, and then pole of a powerful bar magnet brought flat against iron helix and suddenly removed to distance—but no effect produced at test helix beyond that of motion of magnet itself.

26. The flat helix H put between N and S poles of the two bar magnets, the lower ends of bars touching, and then the upper poles put close to or kept at distance from H—but still no effect at indicating helix at distance.

27. A flat copper helix E substituted for H and experimented with but still no effect.

28. Two double iron spirals such as H but side by side—one connected with indicating spiral at distance and a current from 10 pr. of plates and trough sent through the other. No sensible inductive effect.

29. I. Tried in various ways by currents through iron or copper



but no effect at indicating coil. Magnetic poles brought quickly to it and then removed, still no effect.

30. When copper of I carrying current no particular magnetism in the iron that was sensible to needle; those parts of iron wire ends nearest to rings were powerful poles for wire but not powerful for helix used and for battery.

31. Covered Iron wire bent to and fro like a cracker; when current through it no particular action.

32. The iron ring K and cylinder L acts as before and very well.

33. The iron cylinder and helix L. All the wires made into one helix and these connected with the indicating helix at distance by copper wire: then the iron placed between the poles of bar magnets as in former expt. and in fig. Every time the magnetic contact at N or S was made or broken there was magnetic motion at the indicating helix, the effect being as in former cases not permanent, but a mere momentary push or pull. But if the electric communication (i.e. by the copper wire) was broken then these disjunctions and contacts produced no effect whatever. Hence here distinct conversion of Magnetism into Electricity.

34. Perhaps might heat a wire red hot here—try with Marshes magnet.

SEPT. 29TH.

35. M. Put two coils of copper wire round block of wood, string intervening and the coils alternating. Each coil had 34 turns of 73 inches each—each was therefore 2432 [*sic*] inches or 202.8 feet in length. Each had one joint but bright and well twisted.

OCTR. 1, 1831.

36. A battery of 10 troughs each of 10 pr. of plates 4 inches square charged with good mixture of sulphuric and nitric acid, and the following experiments made with it in the following order. The discharge of the battery between charcoal points was very powerful at the first and very good at the conclusion.

37. One of the coils of M connected with the flat helix as in expt. (6), and the other with the poles of the battery (it having been found that there was no metallic contact between the two). The mag. needle at the indicating flat helix was affected but so little as to be hardly sensible.



38. In place of the indicating helix our Galvanometer was used and then a sudden jerk was perceived when the battery communication was *made* or *broken*, but it was so slight as to be scarcely visible—it was one way when made, the other when broken, and the needle took up its natural position at intermediate times.

39. Hence there is an inducing effect without the presence of iron, but it is either very weak or else so sudden as not to have time to move the needle. I rather suspect it is the latter. Use a hollow helix in place of indicating galvanometer and put needle in to magnetise. Compare with effect with Iron present also.

40. The Galvanometer tells better than the flat helix.

41. Endeavoured to obtain evidence of Chemical action as in (11), but could not. Probably the interference of fluid conductors is enough to stop the wave.

42. Could get no heating effect with Platina wire or spark with charcoal with this arrangement at induced side.

43. When a small battery was introduced on induction side so as to send a continual current through that helix and constantly deflect the galvanometer needle, the making and breaking of the contact on the other side was not more sensible if so sensible as with the helix alone. And as contact was made in opposite directions it would appear that when currents in both wires there was little effect or none beyond that with no first current.

44. Now used the Ring K instead of these large coils—all other things for induction, etc. remaining the same as in the former expt., and in (6). With index helix there was powerful effect, and with indicating galvanometer very powerful, pulling the needle quite round, but still it was only momentary. The needle settled as at first though contact continued, and when contact was broken the needle was pulled for the moment in the opposite direction with equal force.

45. Decomposition as at (11)—could not perceive the least trace.

46. Got a spark with charcoal at the end of the inducing wires, very distinct though small—only at the moment of contact or disjunction. Tried to heat a platina wire but probably failed because of too great thickness of wire.

47. Deflected the galvanometer needle by use of little battery () and then passed battery charge through the other helix—but obtained no extra action.

48. When the Ring K was held near to the cap of an excited electrometer, the contact of one of the battery wires with the helix caused a little increased divergence, but on completing the contact it fell to its first position. The effect seems due to the whole mass becoming feebly electrical with the pole which first touches it, and acting by induction on the electrometer. It is nothing important.

49. Two double flat iron helices each containing 19 feet of wire D were placed side by side, one connected with the galvanometer and the other with the battery, but no effect on galvanometer occurred.

50. See old expts. on magnets in helices.

51. The two helices (iron) D when hung about $\frac{2}{3}$ of inch apart powerfully attracted each other at moment of communication with battery, the direction being the same in both, but in a moment or two continuing the contact the attraction ceased—apparently entirely. Upon breaking the contact for a minute or two and then renewing it the attraction was reproduced, but when contact was broken for a shorter period the attraction was not so strong, and when broken for an instant only it scarcely appeared at all. When iron coils first receive magnetic state they attract strongly; when contact broken they lose that peculiar state gradually, and if before it is much diminished it be renewed attraction is only small. Attraction proportionate to approximation to natural state and to intensity of peculiar state to which it is rising. Query would this happen with copper helices.

52. Cylinder L arranged with indicating galvanometer etc. produced its effect but nothing to compare with ring K.

53. Attraction of filings with Cylinder L very good—a very fine bunch, inch or more long, fell off moment contact broken—good class expt.

54. Arranged Sturgeon's plate for Vibration—20 vibrations were necessary to diminish it from one arc to another—then hung two iron helices D over the edge of the plate so as to act as the poles of a magnet on the sides of the plate, but there was no sensible

difference in the number of vibrations. Then used two poles of two bar magnets instead of the helices, and then 10 vibrations made the same diminution in amplitude of vibration as 20 before or thereabouts. But the poles of the magnets were far stronger on a needle than the helices were. Still doubt that pure Electro-magnets will produce Arago's effect.

OCTR. 17, 1831.

55. Have prepared two pieces of apparatus—N a piece of musket barrel $\frac{7}{8}$ of inch in diameter, variable in thickness but about $\frac{1}{16}$ of inch. This was covered by one piece of copper wire 61 feet 4 inches long, in a helix passing from end to end and back again (in the same direction), so as to surround the barrel four times.

56. O a cylinder, hollow, of paper, covered with 8 helices of copper wire going in the same direction and containing the following quantities

	f.	in.
1 or outermost—	32	10
2 — — —	31	6
3 — — —	30	
4 — — —	28	
5 — — —	27	
6 — — —	25	6
7 — — —	23	6
8 or innermost—	22	

220 feet exclusive of projecting ends all separated by twine and calico. The internal diameter of paper cylinder was $\frac{13}{16}$ of inch in diameter, the external diameter of whole $1\frac{1}{2}$ inches and the length of copper helices (as a cylinder) $6\frac{1}{2}$ inches.

57. Expts. with O. The 8 ends of the helices at one end of the cylinder were cleaned and fastened together as a bundle. So were the 8 other ends. These compound ends were then connected with the Galvanometer by long copper wires—then a cylindrical bar magnet $\frac{3}{4}$ inch in diameter and $8\frac{1}{2}$ inches in length had one end just inserted into the end of the helix cylinder—then it was quickly thrust in the whole length and *the galvanometer*

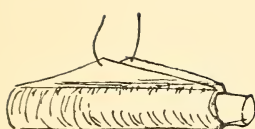
needle moved—then pulled out and again the *needle moved but* in the opposite direction. This effect was repeated every time the magnet was put in or out and therefore a wave of Electricity was so produced from *mere approximation of a magnet* and not from its formation in *situ*.

58. The needle did not remain deflected but *returned to its place* each time. The order of motions were inverse as in former expts., —the motions were in the direction consistent with former expts., i.e. the indicating needle tended to become parallel with the exciting magnet, being on the same side of the wire and poles of the same name in the same direction.

59. When the 8 helices were made one long helix the effect was not so strong on the galvanometer as before, probably not half so strong. So that it is *best* in pieces and combined at the end.

60. When only one of the 8 helices was used it was least powerfull --hardly sensible.

61. Made a sort of jacket of tin foil round a paper cylinder so that, being separated at the edges by paper, the galvanometer wires could be attached to. Then pushed magnet in and out but could perceive nothing at galvanometer. Could hardly indeed expect it, because as magnet introduced there was the part in advance ready to carry the current back. Now in coil, the part in advance could not do so. But jacket may be effectual with iron in its place made a magnet at once, either by contact of bars or by helix round it.



OCTR. 18, 1831.

62. Again charged battery of 12 troughs, 10 pr. each 4 inches square.

63. Re-experimented with block and coils M () connected as before with the Galvanometer. When battery was connected with one wire the other very feeble affected galvanometer. When contact was broken the galvanometer was affected the other way—the effect was very small, but it did not depend upon electricity of tension diffused from battery, as was evident from the direction of the disturbance.

64. Then concluding that there might be a powerful wave though too sudden to move Galvanometer needle and more like a com-

mon electric shock—use a hollow helix instead of the galvanometer, and put two or three unmagnetised needles into it; found they were made magnets instantly by contact of the other wires and magnets of the contrary kind when contacts broken. Hence mere wires do induce upon each other, but action very sudden and quick.

65. Interposed brine and two copper plates, of large surfaces, in the Galvanometer circuit to see if by retardation might render effect on needle more visible—was just as before, not more—hence *can pass* fluids though it does not decompose them.

66. Sent the current of the battery through a rod of copper, the rod being at the same time connected by two other wires with the galvanometer—to see if on the current ceasing there was any return in copper rod; but could find no effects. Perhaps ought to use helix and needle because of very quick action.

67. Same expt. with iron rod, obtained no action.

68. Now used the arrangement O, connected spirals 1, 3, 5 and 7 end to end to form one long helix for battery circuit, connected 2, 4, 6 and 8 with similar ends together () for galvanometer connection. When all was arranged and the middle of O was empty or had wood only, then there was very slight momentary effect on galvanometer. But on using helix in place of galvanometer then needles were rendered magnets very sensibly and reversed at pleasure.

69. On repeating expt. with copper bolt in middle of O still effects as before.

70. On repeating expt. with iron bolt in middle of O then Galvanometer needle powerfully pulled aside even 70° or 80° , coming to rest if contact continued, and occurring in opposite direction when contact broken. Hence effect of iron very evident. On using helix and needles in place of galvanometer the magnets formed were stronger than if iron not used, but the difference was not so great as with galvanometer.

71. Arranged O so as to be able to make Sturgeon's vibrating experiment with it, either with or without iron axis; the plate being allowed to vibrate from one extent or arc of vibration until it had diminished to another, these being marked. Now when the helices O had no current through them the average vibrations of the pendulum and plate were about 19. When the current was



passed through it was nearly the same. When the iron bar was in the middle, but no current, still nearly the same. When iron bar and current also the number was only about 15. It is true, however, that end of iron bar was nearer a little than end of helix, but still helix with current and no iron seems to be doubtful in effect.

72. The current was sent through helices 1, 3, 5 and 7 as one long helix. Must suspend plate by glass horizontally so as to be free from retardation at point of support.

73. Expt. with N. On sending Electric current—powerful magnetism, more so on needle than if iron not there—far more; but pole of iron and pole of helix same kind, say S. But there was no tendency of N pole down middle of iron cylinder; it always flew to the edges, hence quite unlike helix alone, as if therefore currents inside the cylinder were reverse direction to those outside.

74. On putting needles into the iron cylinder whilst an electro-magnet, if in contact with iron then ends assumed state of opposite poles, i.e. S gave N. If iron had been away that end of needle would have been south. On holding needle in axis of cylinder so as not to touch and then making contact there was no charge given to needle. Hence evident that Magnetic power of helix cannot penetrate this iron cylinder, but is absorbed as it were by it. Extraordinary that as there is this direct action there should not be more reaction of magnet on wires.

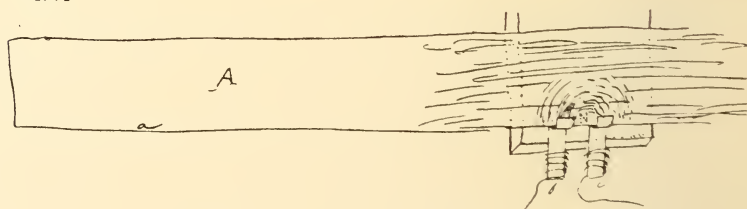
75. Expt. with O: arranged all the helices ends together as one (i.e. like ends together) and connected with a little hollow helix, then put a needle in latter and thrust cylinder magnet into former; withdrew latter and then former; introduced latter and then former, and so on, but could not so get evidence of any magnetism communicated to the needle.

OCT. 24, 1831.

76. Used cylinder O: all similar ends bound together and connected with Galvanometer—an iron cylinder of 12 inches long in O and contacts of magnets as in (33) made and broken—affected the Galvanometer very well.

77*. A large magnet was laid down on a table, the north pole as indicated by a needle being at N—it was covered with paper—a

* [77]



long slip of copper, perhaps $\frac{1}{16}$ of inch thick, was laid across it, with the edge *a* amalgamated: little bits of copper plate were bent as at *b*, *c* so as to form a sort of groove to receive the edge *a*, and these were amalgamated to make contact, then being placed as in the figure with mercury between the conductors and edge. The slip *A* was drawn quickly to and then fro, but no motion was observed at the galvanometer. The hopes were that the pole being at *N* a semi-vortex would be formed and electricity gathered up by the conductors at the section of the vortex occasioned at the edge of the plate. Still it may do with more delicate apparatus and more powerful magnets.

OCTR. 27TH, 1831.

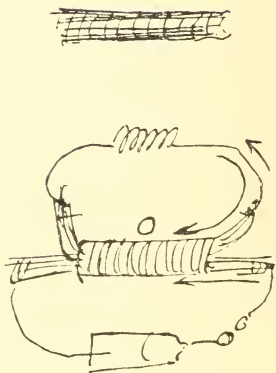
78. Tried arrangement above with better adjusted conductors and with much more delicate small galvanometer—got no effects.

79. Used rotating wheel—conductors good thick copper both well amalgamated—put bar magnets, one pole over the opposite pole of other bar under, and connected other ends of bars. Hence bars were horizontal and along the plate but think it ought to do; yet got no effects.

80. Used a basin of mercury and touching or collecting conductors covered with paper except at edge as it were of mercury disc. Put one magnet above the other below, but got no effects when mercury made to revolve.

81. Thought there might be a kind of statical effect or pressure in the electric fluid, so that a narrow wire would only convey that produced from an area equal to its own, and therefore used thicker wire, but still obtained no effect.

82. Tried if common electric discharge could produce this kind induction. Used O. Coils 1, 3, 5 and 8 [? 7] were connected at end as bundles and connected with outside and inside of Leyden jar. Coils 2, 4, 6 and 8 were similarly connected and attached to a hollow helix in which a needle was placed. A needle in the trial helix became magnetic, North pole being to the left hand. A needle in helix O also became magnetic, but with less force and more labour, but N pole also to left hand. Hence it was proved that the magnetization in trial helix was not effect of induction, for induction would have caused a current in the direction of the



inner arrow, whereas the effect was that of a current in direction of outer arrow. In fact a little of the positive electricity had passed through the further as well as near helix and produced similar effects in both.

83. Tried sparks, but had the same effect—no sensible induction.

84. Prepared to go to Mr Christie's to-morrow.

OCT. 28, 1831.

85. At Mr Christie's to-day making many expts. with the great magnet of the Royal Society. a, a are the ends of the projecting poles of the magnets: each is 12 ? inches long and 3 ? inches wide and they are about 10 inches apart. A soft iron cylinder $\frac{3}{4}$ inch in diameter and 13 inches long was put through O—all the ends of O helices made into 2 bundles and these connected by long copper wires, bell wire, with the last galvanometer that I made in a jar. This Galvanometer was about 10 feet from the magnet and in about the position marked in the sketch*. In altitude it was rather above the middle of the poles.

86. By connecting the two poles (magnetic) by the soft iron cylinder, when connection between the galvanometer and wires was not made, the galvanometer was very slightly affected, so little as to be barely sensible. But when wires *were* connected, then on making or breaking the magnetic contact with the iron cylinder—a powerful pull *whirling the Galvanometer needle* round many times was given.

87. As the helix or cylinder were moved to or from the magnet, *not touching*, corresponding effects were exhibited by the galvanometer.

88. When the contact was continued—no permanent effect on the needle was produced. Even with this powerful magnet the effects were only for a moment as in former cases at home.

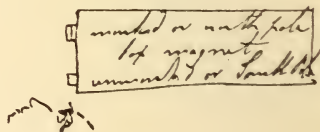
89. As the evidence of a strong current for the moment was visible we tried other actions. Easily made magnetic needles when a helix (hollow) was substituted for the galvanometer.

90. On bringing ends of short wires from the ends of the helices O to the tongue and gums could get no taste or flash.

91. Could get no spark by charcoal and wire—could not heat platina wire of the fineness I possessed, but I had none of Wollaston's Silver platina.

* [85]

galvanometer



92. Could get no chemical action on Sul. copper though took care to repeat contact at proper times, etc. etc.

93. Re-arranged Galvanometer—tried a jacket like that of (61) but of thick copper plate—put with paper on the soft iron cylinder. Obtained a good effect at the Galvanometer. Put on three jackets and connected at projecting parts—somewhat more of effect but contact not good with wires—too hasty.

94. Put paper on iron cylinder and took 6 turns of copper wire on it. Very powerful effect at Magnetic contacts and disjunction.

95. Took only a half round of wire on iron cylinder—still excellent effect on needle.

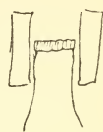
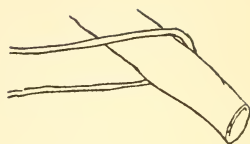
96. Brought helix O up suddenly between the large poles of the magnet; it having no iron bar in its axis. The needle was strongly affected; and also upon its removal as in former cases. This of course a mere effect of approximation and that not very near—not subject to any objection founded on notion of the iron exerting a momentary peculiar action at time of becoming a magnet—is directly connected with Arago's expt.

97. A copper bolt $\frac{3}{4}$ inch in diameter put through helix O: not more action than without.

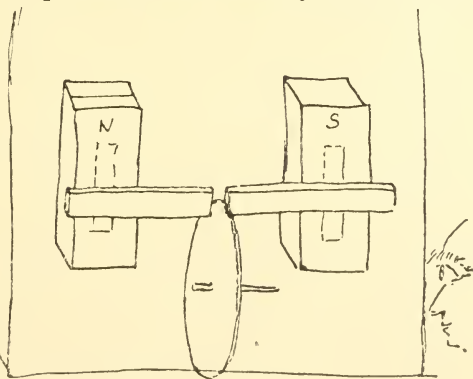
98. A thick iron wire put through helped to increase the action.

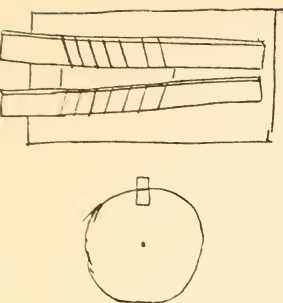
99*. Made many expts. with a copper revolving plate, about 12 inches in diameter and about $\frac{1}{5}$ of inch thick, mounted on a brass axle. To concentrate the polar action two small magnets 6 or 7 inches long, about 1 inch wide and half an inch thick were put against the front of the large poles, transverse to them and with their flat sides against them, and the ends pushed forward until sufficiently near; the bars were prevented from slipping down by jars and shakes by means of string tied round them.

100. The edge of the plate was inserted more or less between the two concentrated poles thus formed. It was also well amalgamated, and then contact was made with this edge in different places by conductors formed from equally thick copper plate and with the extreme end edges grooved and amalgamated so as to fit on to and have contact with the edges of the plate. Two of these were attached to a piece of card board by thread at such



* [99]





distances that they might come in contact with two near parts of the edge of the plate at once; these conductors being connected by wires with the Galvanometer.

101. The circular plate was in all the expts. nearly in the plane of the magnetic meridian, the Galvanometer in the same place as before. In the following notes and diagrams the plate will be represented by a circle looked at from the west or from the eye (~~eye~~) in the above sketch; the direction of its motion will be represented by arrow heads. The place of the poles (magnetic) by a red area thus $\square^1$, and the place of the conductors by black sketches thus $\parallel$.

102*. The Galvanometer had two needles put north and south, one between the helix the other above, but the upper one gave by its stronger power direction to the whole, and the observations were always made upon its south or unmarked pole (that pointing south).

103†. When conductors were on edge of plate equidistant from place of poles, and plate raised up till edge level with middle of each pole and then turned as in the figure (from right to left above), then galvanometer gave indications and the S pole of the upper needle passed towards the *East*. But when plate turned the other way, all other things being the same, the S pole went *West*.

104. The direction of the Galvanometer wires from the conductor is evident above². The effects were very distinct and constant.

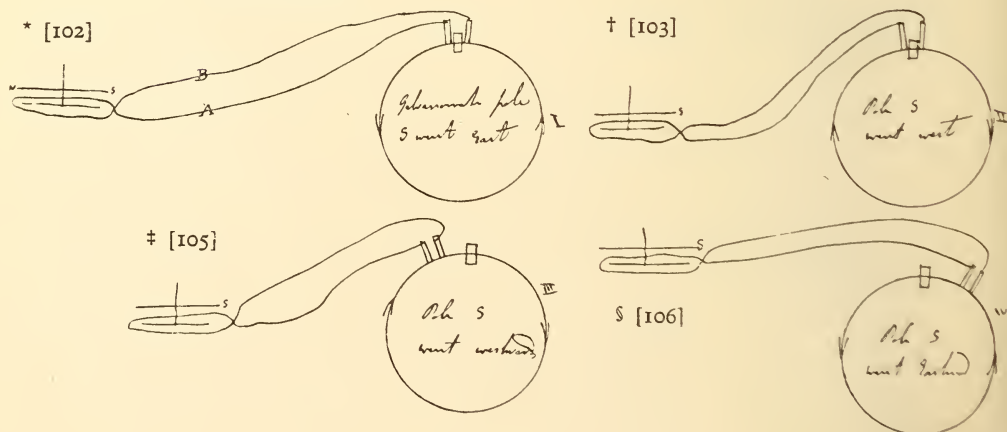
105‡. Next held the conductors against the edge as if they were fixed to it, and moved them with the circle by the Magnetic poles. When the motion was in the same direction as in the last expt., the S pole went west as before.

106§. But when the motion was reversed and therefore in the same direction as in the first expt. the S pole went east, i.e. the contrary of the last and the same as the first.

107. All these effects were constant in direction but difficult to obtain regularly, because of the difficulty of holding both con-

¹ The small rectangles here referred to, which were drawn in red ink in the manuscript, will be seen in diagrams to pars. 101 to 107 inclusive.

² See diagrams.



ductors in contact at once—both for that the edge of the plate was not perfectly regular and also that the stand was not steady. 108*. Then suspecting terrestrial action, especially as plate was revolving nearly in Magnetic meridian, the latter was raised until the magnetic poles were in the plane of the magnetic equator of the revolving plate, but the effect was the same, i.e. the south pole went west when the plate moved from left to right above. By depressing the place of magnetic poles still lower still the same deflection was produced when the plate revolved the same way.

109. Hence the earth's effect either null or too small to confuse the experiment.

110†. Then endeavoured to examine effect more minutely. Put conductors as in the figure, i.e. the left hand one between the poles and the other at one side on the right; then revolving the plate as the arrows point out the S pole went *east*.

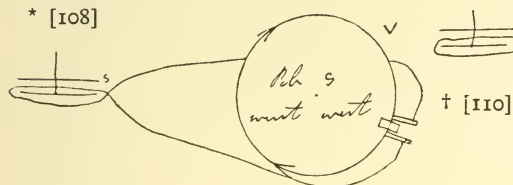
111‡. But on making the motion and every thing else the same, except that the right hand conductor was between the pole and the left a little to the left of it (which did not require more than an inch of displacement), now the S pole went *west*, i.e. the reverse of the last expt.

112§. Hence it was evident there ought to be a nearly neutral position, and on examining the position of equidistance more carefully it was found that the power though westerly was very weak and depended more upon irregularity of contact than constant action. This had every appearance of a neutral position.

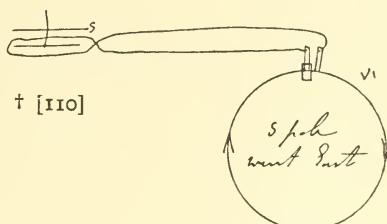
113||. Now the experiment was repeated except that the motion of the plate was reversed. The conductors being placed as in vi, south pole went west instead of east.

114¶. On placing conductors as in vii the south pole went east instead of west.

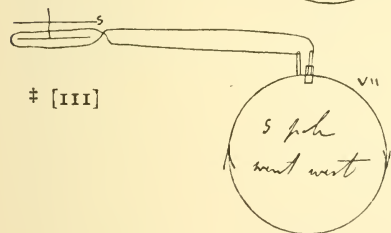
* [108]



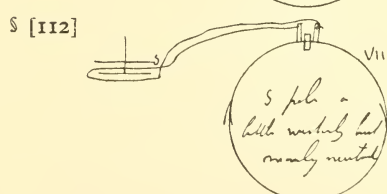
† [110]



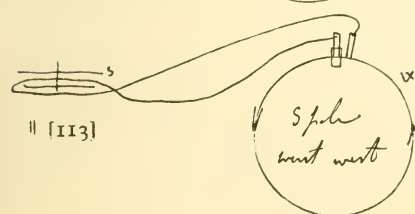
‡ [111]



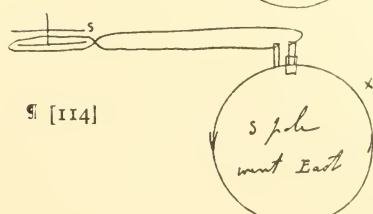
§ [112]



|| [113]



¶ [114]



115. Hence changing the direction of the motion of the plate changes the current, and also changing the conductors to the right or left reverses the current.

116. Suspected from all this that a single conductor would do more than two, and that the condensed imaginary bisected vortex was not so definite as supposed, if existing at all. The wire coming from the upper coils of the Galvanometer was therefore fastened round the brass axis of the plate as the most neutral part of it, and the conductor from the other wire end applied to the edge of the wheel.

117*. When the wheel was revolved from left to right above and the conductor placed between the magnets the S pole of galvanometer went powerfully *west*, and when the conductor was placed either right or left of that still the S pole went west, but with less force. Even when a good way removed the S pole went westward.

118†. On the contrary, when the wheel revolved in the opposite direction the south pole went *east* most strongly when the conductor was directly at the magnets—less strongly when removed right or left as in the faint figures.

119. Hence it is easy to see how two conductors acted. They only shewed the difference of intensity of the two currents setting into them, and consequently by changing the conductors with relation to the strongest part of the plate the direction of the current in the wires and galvanometer was changed and therefore the direction of the needle. The neutral position was that in which each conductor tended to receive a current of equal intensity and in the same direction, consequently there was no circulation.

120. When the conductor was fixed on the plate, and with the plate itself moved forward from left to right above, the S pole went west first as if the plate had moved without the conductor.

121‡. When the plate and conductor moved together by the Magnetic poles in the opposite direction the S pole went east—again as if plate had moved without the conductor.

122§. When the two conductors were placed as in the neutral position viii, but connected as one as in figure, then revolving

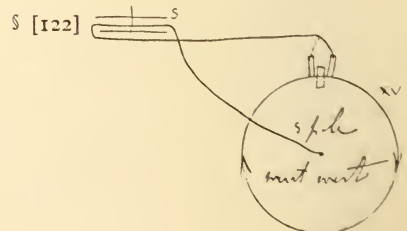
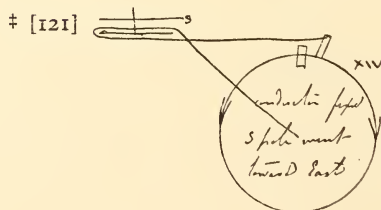
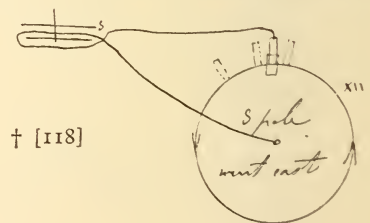
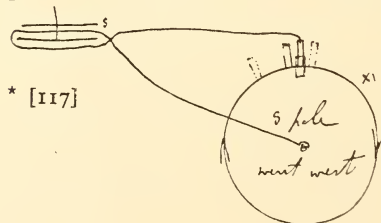
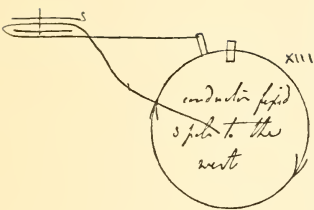


plate made S pole of needle go *powerfully* west. On reversing motion of the plate it went as *powerfully* east.

123*. Now raised the plate so that the projection of the Magnetic pole should be quite within the edge of the former.

124†. But although supposed vortex thus nearly included, effects were as before, i.e. a current of the same kind set off from all the parts of the edge of the plate near the pole whilst the rotation one way. But on reversing the rotation the deflection of the needle at the Galvanometer was reversed.

125. As now the edge could be seen and the contact better preserved, it was found that whilst the plate continued to revolve the Galvanometer needle was permanently deflected.

126‡. On raising the plate so that the magnetic poles were much nearer the center still effect was the same and the deflection was very sensible. It was reversed with the reversal of the rotation of the plate. Hence if any vortex it must be very diffuse.

127. To ascertain effect of vicinity to one pole or the other, one pole was quite taken away from plate and only the other left. The effects were exactly of the same kind, though not so strong as the former.

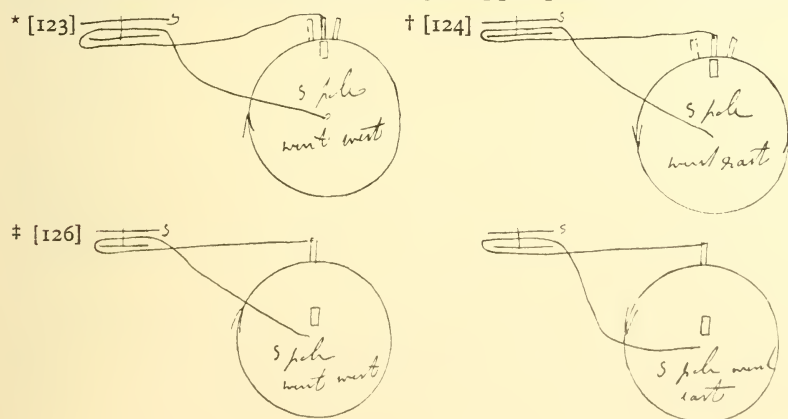
128. None of all these effects took place when the plate was made to revolve away from the magnet. They occurred very feeble when the plate was placed between the large magnetic poles, each being then several inches from it.

129. No electric effect from friction, mercury, etc. etc. could have therefore led to mistakes.

NOVR. 4TH, 1831.

130. Again at Mr Christie's—making expts. He has had two iron bent bars made, so as to apply to sides or ends of large poles and thus concentrate them into two smaller poles, one over the other (the axis of these poles being perpendicular), and so that either north or south pole could be made uppermost. These bars were about $\frac{3}{4}$ of inch square and consequently the face of each pole presented that area.

131. He had also fitted up the large copper plate on a table with



a horizontal motion, so that it could be brought up between the poles and revolved there.

132. The character and position of the poles and wires at the last day were first verified. The large magnet stands nearly N and S, its poles towards the north and the marked or north pole to the East, the other to the west. The Galvanometer was to the North of the magnet and its wires as before.

133*. The plate was now made to rotate horizontally, moving as the arrow heads point. The galvanometer wire A went to the conductor at the edge by the poles and the wire B to the center of rotation. The S end of needle went W.

134. On reversing the motion of the plate the S end went E.

135. On putting wire B on plate a little way from the axis effect produced agreeing with the motion.

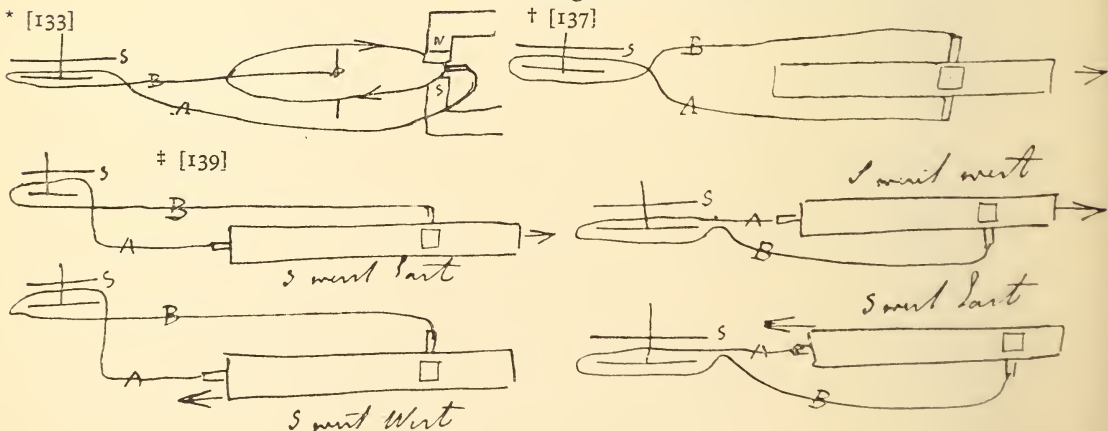
136. A place could be found between the edge of the plate and the centre in which the electricity was not evolved, i.e. if both being placed there, one was then moved towards the rim it would receive one electricity, if towards the axis another. This ought to be in fact the quality of the line passing under the center of the magnet, and therefore extend right and left from the magnet on the plate and parallel to the circumference.

137†. Then experimented with plates, as being simpler; in the figures it is supposed that you are looking down upon the plate, the north or marked pole above, the S pole below. A plate $1\frac{1}{2}$ inch wide, 12 inches long and $\frac{1}{8}$ thick, of copper, was passed between the poles in the direction of the arrow; the conductors of lead being at the place of the poles on each side as figured. The S pole went East.

138. On reversing the motion the S pole went west. These effects very distinct and good.

139‡. Then to shew opposite character of Electricity on the two sides, the wire A was made fast to the end of the plate and the wire B touched conductor on one or other side of the plate at place of pole. The following were the results¹, North or marked pole of Magnet being above.

¹ The diagrams are referred to here.



140*. Now put conductors at end of the same bar and carried it through between the poles transverse to their axis; and at about the middle the motion of the needle was as in the figures.

141. The effect was as strong as if the conductors had been held against the sides of the bar when passed through, thus

142†. When the bar with the conductors at the ends was passed lengthways between the mag. poles there was no effect either way.

No effect on Galvanometer.

143. When narrower plates of copper were used the effects were produced as before, but there was no great or even sensible difference in the intensity of effect.

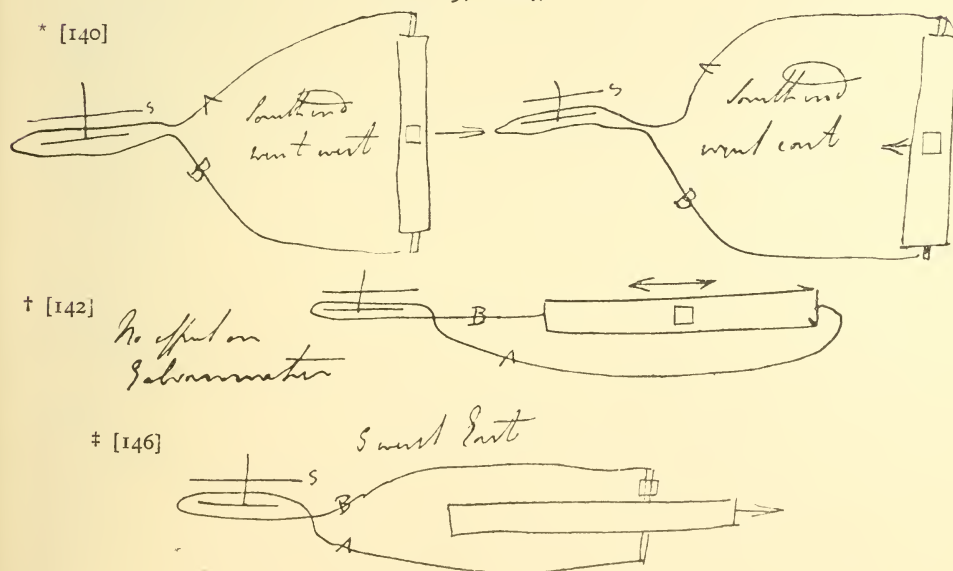
144. When a mere copper wire, amalgamated, was drawn through between the conductors and poles the effect was produced, but not so strong as with the plates. Perhaps because it was thinner, perhaps because amalgamating mercury might wrap over it and conduct and perhaps also because of its being narrower. I think wider plates are better.

145. When an *iron plate* of 12 inches by $1\frac{1}{2}$ inches and $\frac{1}{2}$ was used, it being turned at the edges and amalgamated, it gave effects the same in direction and kind as copper but stronger, but then the Magnetic poles were attracted to it and were nearer, for there was only a slip of card board between the soft iron bar and the poles. On the whole do not think it was stronger than copper at the same distance.

146‡. When copper plate was quite out of polar axis of magnets and moved as in figure, still effects, which though not so strong as when plate just between poles were of the same character, for S pole went East.

147. In this experiment, as in those of the last two pages¹, the North or marked pole of large magnet was above, i.e. between the sketches and the eye of the observer.

¹ Pars. 137 to 147.



148. Now because of better contact with the irons on the magnet they were reversed, and consequently the south or unmarked pole was uppermost, the north or marked pole lowermost; but the polar axis was still perpendicular.

149. A copper wire $\frac{1}{8}$ diameter drawn between the poles and conductors produced the effect.

150. Being *revolved on its axis* between the poles and conductors, it produced no sensible effect: the little produced was apparently due to lateral motion, not to the revolution.

151. When the magnetic poles were in contact and the Magnetic circuit closed there was very little effect produced by a plate (copper) drawn between the conductors close to the shut poles. When the poles were opened by a card the effect was a little more but still very small.

152. A *lead plate* 12 inches by $1\frac{1}{2}$ and $\frac{1}{5}$ was tried—it produced plenty of effect on the Galvanometer—Motion, etc. the same as with copper.

153*. A tin plate 4 inches square being tried gave plenty of effect, and the direction the same as before, i.e. south end went East, but now the South pole of great magnet uppermost.

154. A similar plate of Zinc: plenty of Effect, same direction.

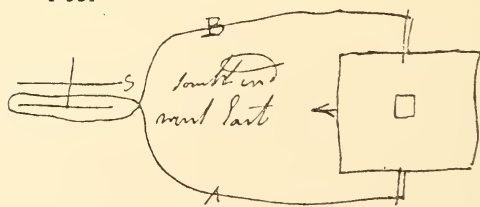
155. The mere conducting wire of the Galvanometer (being in connection) when taken through produced very distinct effect.

156†. Two pieces of copper plate $\frac{1}{5}$ thick, shaped like those in the figure and about 2 inches across, each being amalgamated at the strait edges, put together and carried between poles produced plenty of Galvanometer effect; but when a piece of paper only put between the edges there was no sensible effect on the Galvanometer. Illustrates effects of cuts in Arago's wheel.

157. Tried to get taste or spark on charcoal by trying ends of wires coming from the two conductors when against the plates (square) or on edges of wheels, but could not.

158. Put the circular plate up again, having amalgamated part round middle and attached one conductor to that part and the other to the edge; having thus got the most powerful arrangement then brought wires from the conductors to two platina plates and put a drop of sulphate of copper or nitrate of silver between. Even put a slip of paper moistened with the solutions between. Yet got no decomposing effect. Yet when Galvanometer was substituted

* [153]



† [156]



for the drop of solution, even though through much larger wires an oscillating effect equal to a permanent deflection of 45° or 50° could be obtained.

159. Made a voltaic circuit of a single pair of plates—taste sensible and decomposing action sensible—but the effect on the Galvanometer powerfull.

160. Weakened the solution and therefore force of the voltaic pair until small on the Galvanometer, but still it sensibly acted on the solution.

161. Arranged a current (voltaic) which passing through the Galvanometer and also a drop of solution decomposed the latter and deflected the former about 30° ; the decomposing power was but small.

162. Forgot this time to make same double arrangement with revolving plate arrangement; believe that none or next to none of the electricity would pass the drop, for its intensity must be very low.

163. Brought an iron flat helix end on towards the North or marked pole; the effect and direction was as in the figure, the Magnetic pole being on the further side of the helix and the motion observed as the helix approached.

164. The motion was reversed as the helix was withdrawn from the Magnetic pole.

165*. The copper helices O, being attached to the galvanometer, was advanced towards and between the poles; the direction of the needle was as in the following sketch. The South end went west.

166. On withdrawing the helix the S end went east.

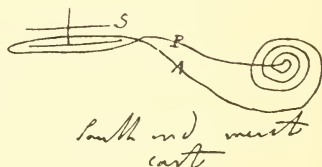
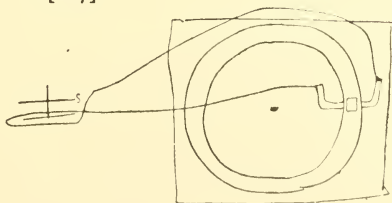
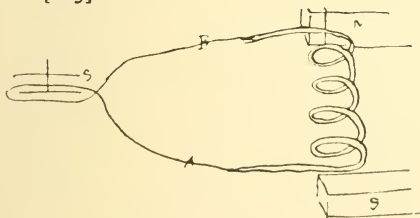
167†. A copper ring about 12 inches external diameter, 1 inch wide and $\frac{1}{2}$ of inch thick was fixed on mill board, amalgamated on the outer and inner edge and revolved between poles of the magnet, in hopes of getting greater power than with the plate, but it was not so; it was not so good. At the same time the contact at the inner edge was not very good; the outer was.

168. Revolved circles of copper and iron of $1\frac{1}{2}$, 1 and $\frac{1}{2}$ inch diameter between and near poles rapidly, but got no good effect from them. There was electricity, but not so copiously as from the revolving plate.

R.S. Paper Read 24 Nov. 1831.

* [165]

† [167]



169*. Measurements of the Magnet. It belonged to Mr Knight. It contains 437 bar magnets each 15 inches $\times$ 1 $\times$ $\frac{1}{2}$ —but it is not well arranged.

170. Could get no sensible effect on a frog with the electricity from the whirling plate between the Magnetic poles.

171. The current from the whirling plate could pass (but very feebly) through the brine between two large copper plates (): care was taken to account for the permanent voltaic action and deflexion due to difference of the plates.

172†. A glass dish was mounted on the whirling table, a pole above and below—then solution put into the dish, the solutions whirled and conductors of platina introduced into them on each side the place of the pole; but no sensible current could be obtained when brine and sulphate of copper solution were used.

173. Another form of the experiment was a bent tube into which S. A. was put, and then the tube, with wires A and B inserted, passed between the poles; but no action took place. It often happened that feeble deflections of the needle took place, but these in such cases could be traced to voltaic action or to thermo electric effects, and distinguished from those of Magneto electric induction.

174. Two pieces of platina foil were held in a flame so as to be ignited, the ends being connected with the galvanometer—but no effects were perceived on passing them between the poles of the Magnet.

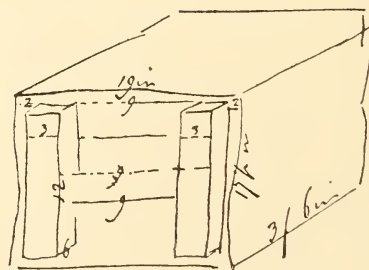
175. Coal gas retort deposit being carried through between the poles gave deflection of needle. Cylinder charcoal did not.

176. Loose ends of wires brought near magnetic poles did nothing; contact is essential.

177. The galvanometer wires were connected and then a part of it held upright before space between 2 magnetic poles; then it was turned half way round into position 2: the needle moved; as the needle returned the wire was turned back into position 1. The motion of the needle increased, and by inverting the wire in consistency with the vibration of the needle 5 or 6 times the needle was made to vibrate thgh. an arc of 60° or 70°. This shews

* [169]

† [172]



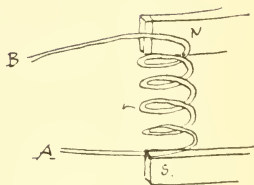
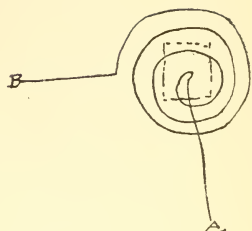
the effect of [illegible] or metals near the poles: Barlow's rotation.

178*. Obtained direction. Consider the marked pole as presented to the Experimenter; then when wires were brought up to it in the positions marked, B and A being connected with the similar ends of Galvanometer wires, the *north end* of needle *went west*. When in the opposite direction the *north end* went East. On removal the motions were reversed.

179. When a flat helix was advanced with its plane towards the end or face of the pole its motions were consistent; thus with the same pole, the helix as in the margin, the marked end of needle went *west* as the helix approached and *east* as it retrograded.

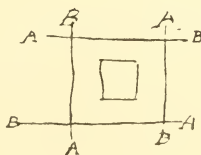
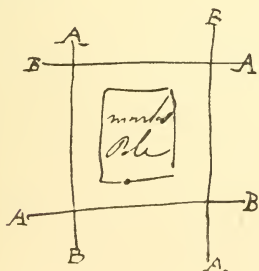
180. When the helix was carried edgewise through between the poles there was a very curious action on the galvanometer. The needle began to move one way, then suddenly stopped as if it had struck an obstacle and then moved the other way. Whether the helix moved between the poles from above downwards or from below upwards, still the motion began in the *same* direction, stopped suddenly, and then returned in the opposite direction. But on turning the helix half round, i.e. edge for edge, then the motions were reversed, but still were suddenly interrupted and inverted as before. Thus the effect of passing through was double—and the direction of deflexion was not changed by changing the motion of the helix, but was by turning it edge for edge. The double action depends upon the two halves of the helix (formed by a line passing through its center perpendicular to its motion) acting in opposite directions. The motion being the same whichever way the helix comes up depends upon the point that at the same time the motion of the helix is changed, the direction of the wires of the approaching half of the helix is changed too, and therefore the deflection at the needle remains the same. All the effects are in fact easily understood, and very simple.

181. The same happens with a helix (cylinder) and caused in part the results noted at page 34 (165)¹. That expt. repeated. On going up, marked end of needle went west. On going through or returning the marked end went East.



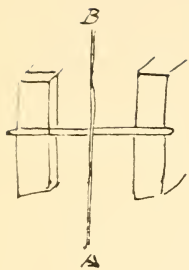
¹ See par. 165 on page 389.

* [178]



182. When the Iron cylinder was put into the helix the directions were the same.

183. A little voltaic arrangement was used which, being interposed between the helix O and the galvanometer deflected the needle about 50° from Mag. Meridian. Then the helix O, both with and without the iron cylinder, was brought up to magnetic poles. There was a little disturbance as induction occurred, shewing that induced current *did* pass liquid in cells, but the needle immediately settled to its former place. Hence electrotonic state does not affect current passing thgh. wires (*sensibly*).



184. The magnetic poles were closed by the 13 inch cylinder and a wire carried up as in figure: the S end of needle went west (?) but there was scarcely a sensible effect. When the helix O was carried up to closed Magnetic poles, scarcely a sensible effect. Hence little external induction by closed poles; probably none if perfectly neutral.

185. When the wire was carried slowly between poles very little action: when quickly much more sensible—was to be expected.

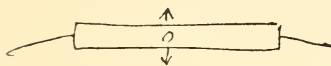
186. Could make *no* magnet of a sewing needle by means of the hollow helix and the current from the wheel arrangement.



187. Mercury revolved in a basin () gave very little indication, but in bent tube, when passed between poles and the action reiterated, gave abundant effect.

188. Could get no effect by use of Galena between poles. Obtained deflections at first but traced them to thermo electric action from warmth of fingers. Nor from Magnetic oxide of Iron.

189. Iron plate carried between poles has decidedly less action than similar copper plate, but still has effect; acts therefore like copper, but is quite distinct in this and its common magnetic action.

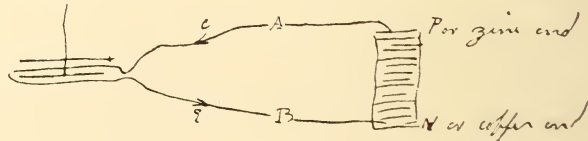


DEC R. 8TH.

190. I have got my apparatus at home to act and have been making precise observation upon the *directions* of the currents, etc., for in former notes there is much confusion from North end and North Pole, etc. etc. etc.

191*. Marked pole $\perp$ above A wire went west. Therefore Electrical current is from A through the galvanometer wire to B when the MARKED pole goes WEST.

* [191]



192*. Needles were made magnets by the same battery currents, as marked. Six troughs were used.

193†. Arranged helices exactly as in figure as to direction, and the needle at *a* became a magnet, marked pole beneath; therefore the electric current induced on making contact is the reverse or contrary in direction to the inducing current, as seen by tracing the circuits in helices *b*.

194. On breaking the voltaic contact the needle became oppositely polarized: hence then the induced current is the same as the inducing current.

195. When wire carried up as in figure to marked Mag. pole, the marked end of needle went *west*. Electric current therefore from B by magnet to A, and so from A through galvanometer to B. When withdrawn the current in the reverse direction.

196‡. When wires were brought up as in following figure the marked end of needle went *west*. Hence currents of Electricity from B to A.

197§. When the marked pole of the magnet entered the helix O as in the figure the marked end of the needle went *west*; hence electrical currents as indicated by the arrows.

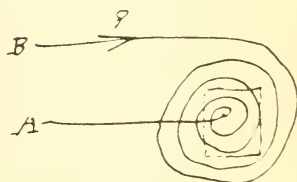
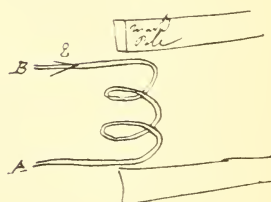
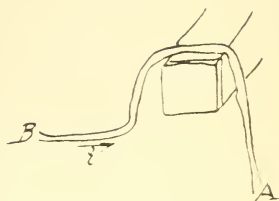
198. On withdrawing the Magnet, the *marked end* went *East*. When the helix was advanced between the poles as in figure the marked end of needle went *west*; hence Electrical current as in figure.

199. When *withdrawn* the marked end went *east*.

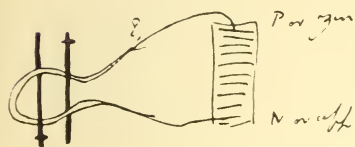
200. When an iron cylinder was put into the helix the directions were the same but very strong.

201. When a helix was carried up towards a marked magnetic pole, considered in fig. as on the other side of it, the marked end of needle went *west*; hence Electrical current as marked.

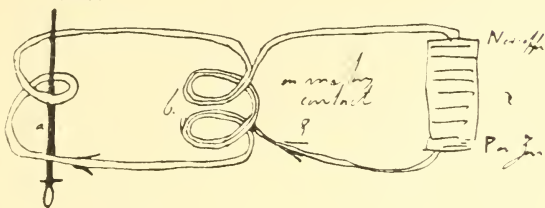
202. When the helix *receded* the marked pole went *East*.



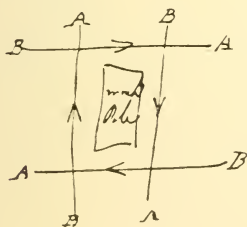
* [192]



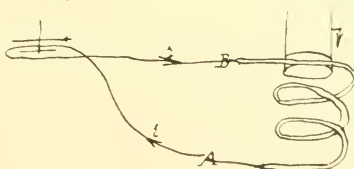
† [193]



‡ [196]



§ [197]



203*. Helices arranged as in figure: on making contact with battery, needle at *a* became a magnet as marked, whilst bar at *b* became a magnet in reverse direction. Hence again inducing and induced current (first) in opposite directions.

204†. As the marked Pole of Magnet enters the ring or helix at *x* in one direction the marked pole of the needle at *xx* takes the opposite direction. The induced current therefore at first the reverse of that in the magnet, or of the current that would make such a magnet.

205. Marked Mag. pole *above*, unmarked beneath, then the plate advanced. The marked end of the needle went *west*, and therefore current in plate from *B* to *A*.

206‡. When plate revolved between two contrary poles of two bar magnets, marked pole above and motion unscrew, the marked end went *west*.

207. When the motion of the plate was reversed the marked end of needle went *east*.

208. Both the revolving plate and the single copper plate produced these effects w[h]en 200 feet of copper wire was included in the circuit, but much feebler than before.

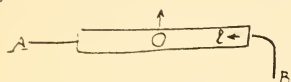
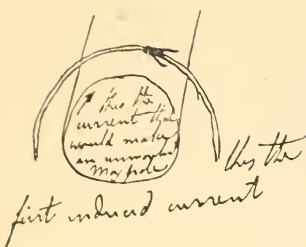
DECR. 9TH.

209. To-day went still more generally to work, for some of former directions only partial, and obtained I think very satisfactory and reconciling results.

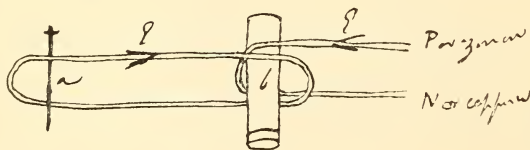
210. When the wire *B A* went before a marked pole of magnet in front from left to right as figured, the marked end of needle went *west*. Hence electric current from *above* downwards.

211§. The direction was the same in the other two cases figured; the marked pole went *west* and therefore the Electric current was from *B* to *A*.

212. When the wire *B A* moved in the direction of the dotted line ----→ the marked end went *west*.



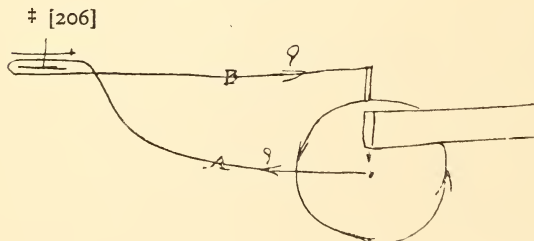
*[203]



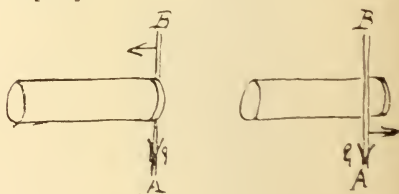
† [204]



‡ [206]



§ [211]



213*. As the *marked end* of the magnet came into and through the ring the *marked end* of upper and usual needle went *east*, but marked end of the under needle went *west* and therefore contrary to entering pole. As pole withdrawn motions reversed. This effect of marked pole consistent with those above; consistent also with 203, 204.

214†. As this helix approached the marked end of a magnet the marked end of the needle —+ went west, hence the current of Electricity as marked $\mathcal{E}$. Any one part of the spiral is as if it were going across the resultants or magnetic curves as marked, and therefore the expt. the same as the former of a single wire, 210, 211, 212.

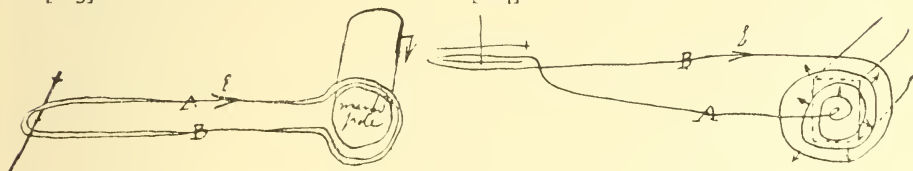
215. Now made a marked pole with a helix and 6 batteries as in figure. Then approach the helix above as before to Magnet. Marked pole of needle went west; therefore the electric currents *opposite*, for that in battery helix is against screw or watch hands, and that induced in approached helix with screw or watch hands. Consistent with yesterday's 193.

216‡. Now made circular plate expt. in three different ways. The plate always turned one way (unscrew) and the gatherers were always connected to B and A in the same way. But the Magnets were changed in position, but always keeping the marked pole above and the unmarked pole below. In all the cases the needle was deflected the same way (i.e. the marked end towards the west), and therefore the current was always the same and from the circumference by the pole to the center. If therefore the position and motion of the plate be the same, the current produced in it is the same in direction in whatever direction the magnet is applied or held, provided the same pole is applied to the same place, i.e. the position of the axis of the magnet is of no consequence provided the magnetic curves are cut in the same direction.

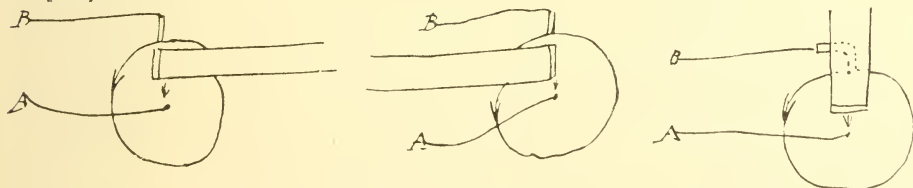


* [213]

† [214]



‡ [216]



217*. Tried Expts. on effect of terrestrial magnetism in evolving electricity. Obtained beautiful results. The Helix O had the soft iron cylinder (freed from magnetism by a full red heat and cooling previous) put into it, and the helix then connected with the galvanometer by wires 8 feet long. Then inverted the bar and helix and immediately the needle moved; inverted it again, the needle moved back; and by repeating the motion with the oscillations of the needle made the latter vibrate 180° or more. When the helix and bar was in the position of the dip and then inverted, the marked end of needle went East, and that was the same whether the upper end went to the right or left hand in the inversion.

218. When the A end was uppermost at first, the marked end of needle went *west* when the helix was inverted either to the right or left.

219. When the bar was taken out of the helix, its inversion at 4 feet from the galvanometer did nothing.

220. The helix O without the iron bar gave by repeated inversion a feeble and similar deflection, very distinct. But putting in a copper bolt rendered it insensible, or so little as not to be decided; the bolt evidently did harm yet it touched no part of the coil.

221. When helix held steady and bar pushed in and out in the position of the dip there was deflection of the needle just as if the bar was a magnet with its marked pole downwards. Such a magnet gave the same deflection but stronger.

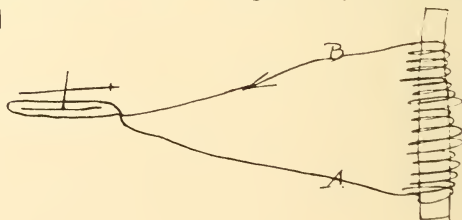
222. When the helix was horizontal or perpendicular to the magnetic needle, then putting the soft iron in and out did nothing; but when inclined this or that way to the magnetic meridian the soft iron acted accordingly, the virtual marked pole being downwards.

223. Found that on using thick wires in place of thin ones much greater effect was obtained at the galvanometer.

224. When a cylinder magnet was retained in the helix but inverted with it the needle was deflected as before, and thus the influence of the earth in disturbing the distribution of the magnetic influence easily shewn. Useful mode of detecting derangements not otherwise visible.

225. Bears also upon Barlow's rotation of iron shell and also upon question whether iron becomes magnetic by the earth: think it does.

* [217]



226*. Made Arago's experiment with the Earth magnet only. No magnet used, but the plate put horizontal and rotated. The effect at the needle was slight but very distinct and could be accumulated upon the needle by reversion and reiteration of motion, etc. etc. When plate revolved as marked the marked end of needle went East. No iron used here, wires not more than 18 inches long and only bell wire. If had used thick wire in galvanometer and for conductors probably much more effect.

227. Hence Arago's plate a new Electrical machine.

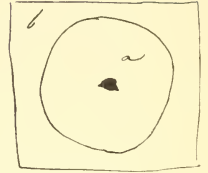
DEC R. 16TH.

228. a is a disc of copper thick $\frac{1}{5}$ of inch, and about $1\frac{1}{2}$ inches in diameter; b is a piece of equally thick sheet lead with a hole cut in it in which disc a can revolve loosely; the inner edge of b and outer edge of a are amalgamated; a is mounted on a copper axle with a little cup at the top to make contact. On putting mercury between a and b to make contact, revolving a and connecting the galvanometer with the axle of a and the lead b , it was feebly affected; though no magnet but the earth was used. The effect could be accumulated until very distinct.

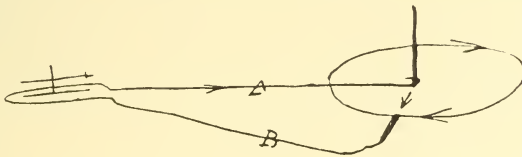
229. On putting the apparatus over the pole of a bar magnet then it was easy to affect the galvanometer. As the disc revolved one way the electricity was from the center to the circumference; as it revolved the other way from the circumference to the center. This shews that so long as the wheel moves, electricity is evolved, and as the radii are here not passing the pole as a whole but are always in the same relation to it, it shews that it is not mere vicinity but motion which evolves the electricity. Must consider this more presently.

230. Probably build a machine up this way.

231. I could not decompose solution of copper with this machine.

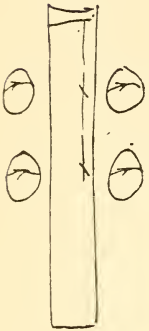
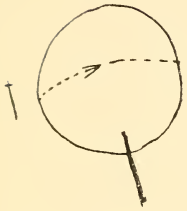


* [226]



EXPTS. IN TERRESTRIAL MAGNETO- ELECTRIC INDUCTION

DECR. 21.



232. Prepared a magnetic needle by sticking two halves of a sewing needle, magnetised, into stem of hay, and suspending the whole by silk fibre in a cylindrical jar, so as to be able to revolve; the little needles were about 4 inches apart and the lower one gave terrestrial direction, being most powerful of the two.

233. A common electrical ball 4 inches in diameter was fastnd. to a stiff wire so as to be rotated easily between the fingers (like a mop) in any direction. It was not magnetic when at rest—was hollow and light.

234. Held ball on west of upper needle outside the jar. When revolved clock fashion as in figure, marked pole went east or from the ball. When ball revolved unscrew or reverse to former direction, marked pole went west or towards the ball.

235. Now held ball on west of lower needle. When revolving screw fashion the marked pole went east or from ball—when revolving unscrew, marked pole went west or to the ball—the same as before.

236. Now changed the ball to the east of the needles and when opposite the one or the other, and revolved screw fashion, marked pole went east or towards the ball. When the motion unscrew then marked pole went west or from the ball, both of the upper or lower needle. So that in these four positions, when ball revolved the same way, the same pole of needle always went same way. When motion is direct or screw the marked pole goes east.

237. Then brought up a magnet until the needle stood in a plane perpendicular to the magnetic meridian, and now revolved the ball to the north and the south of the needles, the axis of rotation always being perpendicular to the dip. When the ball was revolved screw fashion the needle moved exactly in the same relation to it as before—all proving that a current of electricity was running round the ball in a plane at right angles to the plane of rotation, and that this current deflected the needle.

238. Bars of soft iron placed in magnetic dip d attract soft iron filings; paper was put on top end of one bar, very fine iron filings sprinkled on it and the bottom end of the other bar brought near them; they were distinctly attracted between these two temporary poles.

239. When swimming on clean mercury or water also the end of such a bar in such a position would attract them, but not sensibly in a horizontal position.

[DEC R. 22.]

239a. Repeated ball expt. (236) to prove what ought to take place, that needle at side of ball and above or below ball was deflected in opposite directions. When ball opposite lower needle and revolved screw or clock fashion the marked pole went *east* as it did also yesterday. But on placing the ball below the needle, a glass plate and jar intervening, and then revolving it screw fashion, the marked pole went *west*. This a necessary consequence of the rotation of Electric current round the globe—it in fact resembles the currents in the galvanometer and the needle moves in the same directions.

2nd Paper dated Decr. 21, 1831.



DECR. 23RD, 1831.

EXPERIMENTS WITH BATTERY.

240. Repeated the experiment with ring K (). Sent battery current from 80 pr. of plates through A helix or side and several times obtained the spark with charcoal at B side. Did not get the spark perceptibly at any time of breaking the contact—always at the making contact. The spark never occurred except at the first moment of contact—not afterwards though the battery contact continued.

241. Sent currents of same battery through a copper wire under water—covered with paper and having a long globule of mercury at its side—but could perceive no indication of motion or other action in mercury when contact made, broken or continued—a little N. A. was added to dissolve the film from mercury and render it perfectly fluid.

242. Put some needles into a hollow helix, passed battery charge thrgh. helix, took out needles, then broke battery connection—these needles were strong magnets. Again put some needles into helix, passed battery charge through, broke battery connection and *then* took out needles. Think they were not so strong as magnets as the former, i.e., that breaking contact had weaknd. them.

243. Can it be true that continued motion of wire or plate is sufficient alone, without removal into increasing or decreasing intensity of power—then wire and magnet revolving together will do—or even magnet revolving without wire or plate. Then also easily find if thick or thin or wire or plate best—then too a more easy machine. That it is so would seem to be the case from revolution of plate subject to earth's magnetism evolving electricity, for there the power must be equal over all parts of the plate—and also again from the electricity of revolving brass ball.

244. If the former be true then surely power can not be direct but oblique or tangential, or else departure from all known laws—action but no reaction—see electrotonic state—or else some effect (equivalent) produced not yet discovered.

245. Important to decide whether electricity is evolved so long as wire moving, or only whilst moving across magnetic curves

of different intensity of power—the former most probable—and if true upon that follows perhaps the electricity of magnet and wire revolving together, and the electricity of terrestrial arrangements.

246. If a magnet rapidly rotated, should be currents of electricity in the iron itself, from the equator of magnet near the surface towards the ends and back down the axis. Can hardly expect to find this by mag. needle because central current act[s] as well as superficial and with equal force on needle. Otherwise revolving magnet ought to alter position of needle over quiet magnet.

247. If rotate hollow cylinder magnet perhaps expect something.

248. If such an action in the earth, then currents of electricity from the equator to the poles, both ways in parts nearest the surface, i.e. if they can be returned back in central parts as axis where magnetic induction more neutralized, or if they can be discharged by differences of intensity under the inductive action—or if discharged by other means.

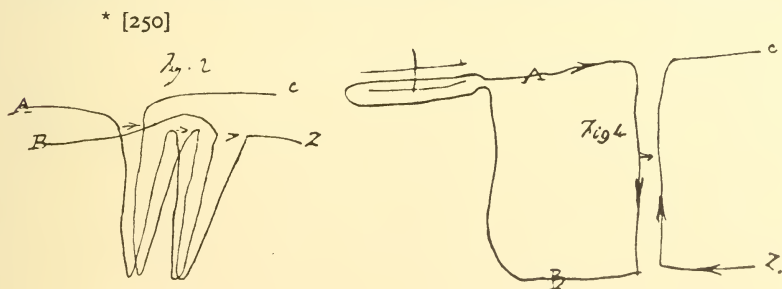
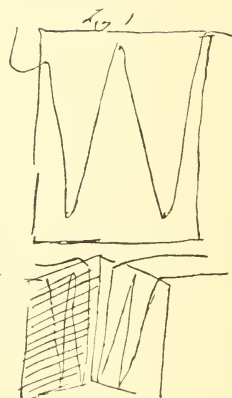
249. Can the Aurora borealis be discharge of such electricity?

DEC R. 26, 1831.

250. Arranged feet of copper wire on board in zigzag form as at fig. 1. Arranged an equal number of feet on another board exactly in the same form and on same scale, so that as one board approached the other the wires approximated until in contact throughout or nearly so. Then covered one board over with cartridge paper to prevent contact. Then connected the ends of a battery of 100 pr. of plates, moderately charged, with one of these wires as in fig. 2* and 4, and the ends of the other wire with the Galvanometer, as A, B. When galvanometer wire was *approached* to the battery wire carrying the current the marked pole of upper needle went east, and when withdrawn from battery wire and current the marked pole went west. Current therefore induced on approaching was opposite direction to the inducing current: and current induced on receding was in same direction.

251. Hence distinctly inducing power of voltaic current after it is formed, and not merely on making or breaking contact. Hence also intermediate electrotonic state.

252. Used helix O, connected one half with battery and the other half of its elementary helices with a hollow helix for the purpose

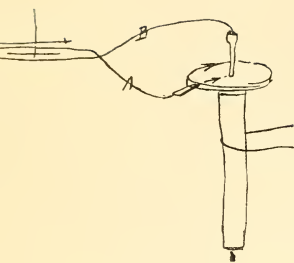


* [250]

of making needles by induction as in expt (). Now made needles magnets by the induced currents existing both upon *making* and *breaking* battery contact. These magnets were oppositely polarized, i.e. those at the *making contact* were the reverse of those at the *breaking contact*, but the first were always the *strongest*. And so when the needle was left in both for the making and breaking, it was not found neutral, but a magnet of the same kind as that of *making contact*.

253. This is probably a consequence of the accumulation in the poles of the pile, for the inducing current on making is stronger than the inducing current broken.

254. Battery current was then sent thrgh. helix O, and a wire connected at both ends with the galvanometer carried by the electro magnet formed, at one end, so as to represent action of magnet on wire. There was a little agitation of galvanometer needle but the effect was so small as hardly to be sensible, and not to allow of direction being determined. But when an iron core was put into the helix, all other things remaining the same, then the passing of the wire showed the effects most distinctly and gave direction consistent with all former expts. Here again difference of electro magnet and ferruginous magnet great.

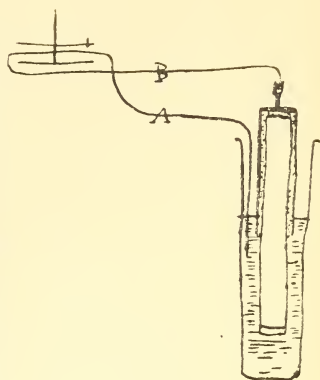


255. A copper disc was cemented on the top of a cylinder magnet, paper intervening, the top being the marked pole; the magnet supported so as to rotate by means of string, and the wires of the galvanometer connected with the edge and the axis of the copper plate. When the magnet and disc together rotated *unscrew* the marked end of the needle went *west*. When the magnet and disc rotated *screw* the marked end of the needle went *east*.

256. This direction is the *same* as that which would have resulted if the copper had moved and the magnet been still. Hence moving the magnet causes no difference provided the copper moves. A rotating and a stationary magnet cause the same effect.

257. The disc was then loosed from the magnet and held still whilst the magnet itself was revolved; but now no effect upon the galvanometer. Hence it appears that, of the metal circuit in which the current is to be formed, different parts must move with different angular velocities. If with the same, no current is produced, i.e. when both parts are external to the magnet.

258. A copper cylinder was fixed by many folds of paper as a socket over one half of one of the cylindrical magnets. The cylinder was closed above by a copper end amalgamated at its edges, and this end carried a cup to make metallic contact by mercury. The lower edge of cylinder was amalgamated, and then the magnet put with its uncovered and marked pole downwards in a narrow jar containing mercury, so that as magnet swam it could be easily rotated by a string round the outside of copper, and the copper cylinder itself touched the mercury in jar below and mercury in cup above. Then these portions of mercury were connected as above with galvanometer, and the magnet rotated—the needle was deflected, thus shewing formation of current in copper jacket revolving *with* but not touching the magnet. The experiment is in fact a repetition of that with the disc just described.

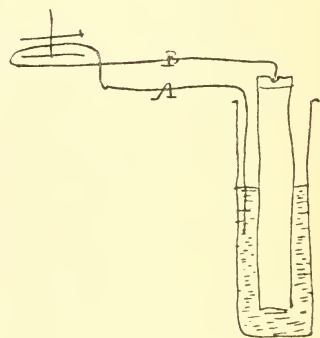


259. When the magnet and cylinder revolved together screw or clock fashion then the marked pole of the needle went west; and therefore electric current was from B to the top of the cylinder, through the cylinder downward and by mercury in the jar to wire A.

260. When the magnet and cylinder revolved unscrew or against clock then marked pole of needle went east and consequently the current was then upwards through the cylinder.

261. These directions the same as if cylinder had revolved without magnet, for now unmarked pole up and direction like that of (226, 215) etc. etc. Results therefore the same as with fixed disc.

262. Now took a cylindrical magnet, put it into jar of mercury, dipped wire A into mercury of jar, and connected wire B with magnet at its upper end in axis by little mercury in a small hole. *Marked pole upwards.* The magnet was $8\frac{1}{2}$ inches long, 5 inches were immersed, $3\frac{1}{2}$ inches projected above mercury.



263. When revolved by string, powerful effect at galvanometer, more than before. If revolved screw or clock fashion the *marked* end went *east*, and therefore current from mercury of jar into magnet, then upwards and out at axis above. When revolved *unscrew* then *marked* end went *west*, and current therefore downwards through magnet. These currents are therefore the same as those in the disc experiment, *same pole being* upwards, and consequently when magnet moves itself the current is through it in

same direction as if a wire or cylinder of copper were moving same way round magnet. Whether therefore magnet moves or is at rest, the directions are the same, and also whether other metal move by it or the metal of itself is used.

264. Now reduced the mercury until only 4 inches of the magnet were immersed, the poles, connection, etc. the same. The electric action was as strong as before and the direction, etc. etc. the *same*.

265. Now reduced the mercury until only $2\frac{1}{2}$ inches of magnet was immersed. Effect stronger than before—*direction, etc. still* the same.

266. Now *inverted* the magnet bringing the *unmarked* pole upwards. All things else the same. Very strong electricity though only $2\frac{1}{2}$ inches. When magnet rotated screw fashion, marked pole of needle went *west*. When rotated *unscrew fashion* the *marked pole went east*. Inversion of magnet had therefore inverted the direction of needle, and all effects in harmony with former results.

267. When therefore magnet continues to revolve in the same direction relative to *its own axis*, Electricity of the same kind may be gathered at *either end* or pole, and electricity of the opposite kind at the equator or the parts corresponding to it.

268. Now reduced the mercury until only about $\frac{1}{8}$ of an inch in depth. On rotating the magnet the strength of electrical action was found weakened a good deal, but the direction was the same as before, i.e. *screw rotation gave western direction* to marked end of the needle, the unmarked pole being upwards.

269. Then gradually added mercury: effect became stronger until nearly half way. It did not much diminish until within an inch of the top—when within half an inch of the top the effect still strong.

270. There is evidence of great power in these experiments, for the electricity had only 2, 3 or 4 inches of the thick magnet to go through, and yet rather went through 27 or 30 feet of thin copper wire.

271. Now revolved the large copper plate in different positions to earth and observed electrical effects produced.

272. When the plate was in the magnetic meridian or in any other Azimuth to the magnetic dip, the axis of rotation being always perpendicular to the dip, then the rotation of the plate produced

no signs of electricity at the galvanometer—connection being made at the axis and circumference as in former cases.

273. When the plate was put upright east and west, and the axis of rotation therefore inclined only 20° from its former position relative to the dip—the plane of rotation making an angle of 20° with the dip—a little electricity was evolved. When the plate was put horizontal, its plane of rotation inclined therefore 70° to the dip, then far stronger electrical effects on rotation than before. When the plate inclined until its axis was parallel to the dip then most effect on the galvanometer.

274. Expts. with a single wire—*beautiful*. A common copper wire (bell wire) about 8 feet long, attached at each end to the wires of the galvanometer, then spread out as in the figure and the loop part carried right and left over the galvanometer. Immediately the instrument needle moved, and by four or five inversions of the wire vibrated 90° or more. This effect of the earth's magnetism on moving wire, and same as effect of revolving ball (), is a truly elementary experiment.

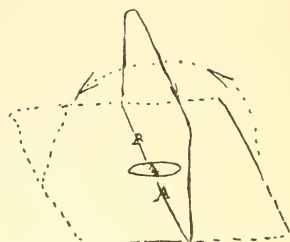
275. When the wire was carried from *west to east* over the galvanometer the marked pole of the needle went *west*; when carried from east to west marked pole of needle went *east*.

276. Then carried wire from north to south and back again—direction as before, i.e. consistent with them, and same occurred in any other azimuth. Thus let dotted line be the dip, and B A a wire in a horizontal plane, having an arrow projecting from it which shall always have B on its right hand and A on its left; then whatever azimuth B A is placed in, if it be moved in the direction of the arrow the current of electricity in it will be from B to A.

277. The wire was then carried up and down as nearly as might be in the magnetic dip, avoiding as much as might be any intersecting motion relative to the dip: scarcely any effect, and that due to the in and out motion of the sides.

278. This is an excellent means of getting the effect due to direction of motion.

279. Carried the wire below the galvanometer and moved it so as to cut the dip: the deflections the same as before, i.e. when moving from east to west above or from east to west below, needle deflected the same way. This ought to be the case.

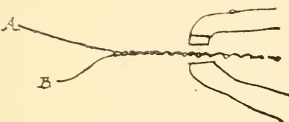


280. Found it better to have a long wire and carry it through long space than a short wire through short space.



281. When wire is bent as in figure and *a* is made a fixed point a good exhibiting effect is produced. As both sides swing out or in together they combine to produce one strong effect on needle, for as the currents formed are in opposite directions they tend to circulate the electricity in the whole.

282. Tried to get effects by carrying the magnet and wire fixed to it to the right and left, so as to alter its position to galvanometer. Ought to produce effects, but the apparatus too weak and heavy. Mag. pole too weak and effect altogether of single wire and single pole too weak to shew the action.



283. Took some covered iron wire, cleaned the end, connected it with clean copper wire and then twisted the two together for 18 inches, after which the ends separated and the wires *A* and *B* of galvanometer were attached to them. Hence twisted part was in contact at end, close together and yet insulated. Passed this wire to and fro, as in figure, between two poles of Daniell's powerful magnet, but got no effect. Hence action on the two metals, iron and copper, equal to each other—no available difference.

284. Then took iron cylinder, put paper round it and rolled the combined part on it as a spiral—one end of this spiral opening out and the two branches being connected as before with the galvanometer. On bringing the soft iron bar to the poles of same magnet, still no effect on needle. The soft bar in this position would lift 25 or 30 lbs. No effect on making or breaking.

285. Then tried the following metallic combinations in a similar way against each other.

Copper and Iron	} but obtained no effect.
Copper and Tin	
Copper and Zinc	
Tin and Zinc	

286. Then tried an iron spiral and a copper spiral, the one 16 inches and the other 18 inches in length of wire; the iron was a little the most powerful but it was also a little the longest.



287. Had a tube bent, put ends of polished copper wire many times bent into it at each end and bent them as in the figure, so

as to compare S. A. in the tube and copper out of the tube together; but obtained no effect.

DEC R. 28TH, 1831.

288*. This morning arranged wires as in the sketch. One long iron wire 120 feet long was laid out in the direction of the meridian; copper wires were fastened at its ends by good contact and then brought parallel to the first, their two ends being at the middle and connected there with the galvanometer. In this form two equal lengths of copper and iron each 120 feet long were subject to the earth's magnetism under the influence of her diurnal motion. No effects were perceived. No difference shewing difference of metals.

289. When one end was made a little warmer than the other then thermo-electric effects instantly shewn.

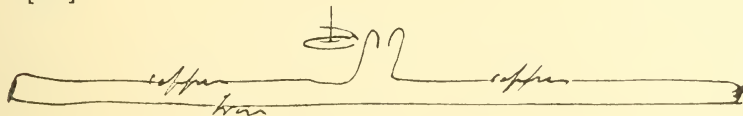
290. Arranged the jar needle () steadily. Carried a wire steadily in its neighbourhood, connected one end of this wire with a voltaic battery of 10 pr. plates, and the other end with one termination of a helix of copper wire, about $\frac{3}{4}$ inch or inch in diameter, containing 50 or 60 turns and the turns insulated by interposed paper. Connected the other end of the helix with the battery. Then the current of the battery passed the helix and the galvanometer and caused a constant deflection in the needle. When quite steady the helix was pulled open, i.e. the turns apart from each other, but there was no change at the needle—nor again when closed up could get no effect. Indeed any induced current could hardly have passed fluid in cells and therefore hardly have been sensible.

JAN Y. 7TH, 1832.

291. Is not the evolution of electricity in the wire caused by an electro magnetic pole a presumptive proof that time is required in electric circuit, and perhaps much time; is not effect due to the wire going in the direction of the current in one part and against it in the other?

292. The electricity in the wire is in the same direction as it is in that side of the circular theoretical current which it is approaching and the reverse of the current in the side it is leaving.

* [288]



293*. Experimented in the pond before Kensington Palace. This is a made pond with a Stucco or other artificial bottom, and is supplied with water by one of the Companies, I believe the Chelsea. There are no springs, hence the water is all alike in quality and probably also in temperature.

294. A clean bright copper plate 2 feet by 1 foot had a thick copper wire soldered on at one corner. To this was made fast by clean metallic contact a copper wire $\frac{1}{20}$ inch thick, and then the plate thrown into the water at the north East corner. The water was very clear and the plate quite immersed, depth about 2 feet or perhaps more. The wire was then coiled round the eastern side on the grass until it reached the south eastern corner, where it was made fast to a similar plate as before, and that plate thrown in to water about 2 feet or 20 inches deep. The plates were nearly N and S of each other and about 160 yards apart—the wire was of course much longer. The wire was then divided in the middle of the eastern side and its ends connected by cups of mercury with the ends of a galvanometer wire to observe any induced effect.

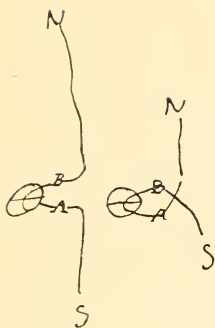
295. At first I obtained deflections of the needle, and these were very regular. When the contact was as in the diagram the marked pole of the needle went west, and the current was therefore from A to B through the galvanometer and of course from S to North through the wire. On connecting the ends cross way the marked pole went *east*, proving the same thing.

296. After some time again made contacts and again obtained same results and direction. Obtained the same a third and fourth time.

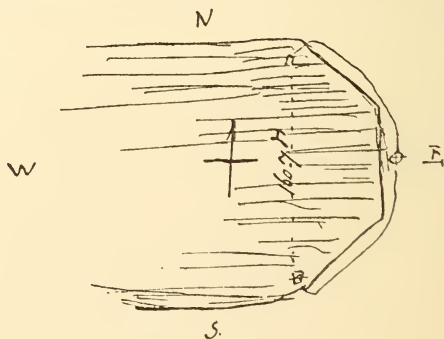
297. Occasionally the vibrations of the needle were irregular, as if the contacts gave currents in opposition to its vibration.

298. Now looked carefully for *ordinary causes* sufficient to account for these effects, and found they had been active. The fingers held one wire shorter than another. It was warmer therefore at the end and in this way thermo electric currents had been produced.

299. Then found that the nitrate of mercury used to amalgamate the copper wires, on mingling with the water above the mercury in each cup, formed an ordinary voltaic apparatus which acted powerfully, notwithstanding that the copper wire seemed bathed in mercury.



* [293]



300. On washing all the cups and wires well in clean water; on using some of the same water to communicate equal temperatures to the two portions of mercury; and on holding the wires by paper handles, then obtained no effect, and do not believe that under these circumstances any magneto-electric effects are produced, i.e. when wire and water have same (diurnal) velocity of motion.

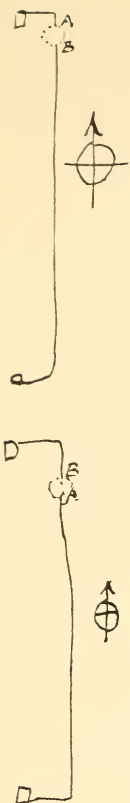
301. It was wonderful to find the electric current from so small a cause as a little saline matter in one cup, or closer contact of the fingers on one wire, go through about 500 feet of water and more than 600 feet of wire—still affecting the galvanometer. It shews the extreme care required in delicate and elementary experiments when this instrument is used. But it shewed also that the circuit was perfect and that the want of magneto electric effects was not therefore due to any interrupting cause.

302. The Duke of Sussex had obtained leave from the King for these expts. to be made in the gardens, and I received all help from Mr Acton [?] and the men that was required. It was but little but was very willingly given.

J A N Y. 12, 1832.

303. Experimented to-day at Waterloo Bridge by leave of Mr Bridell the Secy. Stretched a long copper wire on the Parapet of the Bridge on the western side. It extended from the toll house, Strand side, over six arches and to the sixth pier (these arches are each 140 feet, the piers each about 15 or 20 feet); it was therefore about 960 feet long. One of the plates above mentioned, very clean, was fastened to a wire and let down to the river directly at the toll house. The end of the wire was taken into the toll house by the window. The other plate, fastnd. to a similar wire, was let down into the river at the sixth pier, the other end being connected with the wire just mentioned. The end of the long horizontal wire was taken into the toll house, and thus, these two ends being connected by cups of mercury with the galvanometer wire, the whole became one wire from plate to plate; and the circuit was completed by the water between the plates, which, being in motion up or down, was expected to produce by magneto-electric induction currents rendered sensible at the galvanometer.

304. In the morning the tide was running down at the Bridge



and consequently the water flowing from West to East. On making the contact perfect, as in the margin, evidence of a current was soon obtained—and finally it was found that when the contact was completed the marked pole went east. When broken the marked pole swung back westward. Whether contact was made at A or at B, provided the wires were the same for the same cups the effect was alike, but when wires were crossed the effect was reversed. By making contacts alternately in direct and inverted order the needle at last swung 90° .

305. In the evening $\frac{1}{2}$ p. 6 returned to the Bridge: tide now running up or from *east to west*, the reverse of the morning. Put in the plates as before and at same places and got all in good order. Mr Christie was present. The watermen told me the tide was now running faster than in the morning, and in some parts of the arches between 2 and 3 miles per hour.

306. Obtained now very powerful effects. By continuing the contact a permanent deflection of 5° or 10° could be obtained, and by two or three making and breaking the needle was swung 180° or more. The arrangement was as follows—on completing contact the marked pole went *west*—on breaking it returned towards the east. This effect was obtained again and again and I am sure the arrangements are as marked down.

307. Mr. Pearsall who was present says they are as they were in the morning. My morning note says they are the reverse, but now what is the direction.

308. When contact was made in morning the noted deflection indicated that a current existed in the wire from south to North, and therefore in the morning water from North to South. According to theory, as the water moved from west to east the electric current in it ought to have been from south to north, or the contrary of that found. That current also seemed weak by comparison.

309. In the evening when contact was made a current passed through the wire from South to North, and therefore in the water from North to south, which ought to be the case as the fluid moved from east to west.

310. I inquired about sewers, etc. from the watermen. In the evening and tide rising they all declared the liquor in the sewers was pushed back by the tide, and that the water at the middle and

sides was quite alike. In the ebb (morning) they said the middle water was purest. Go again tomorrow morning to continue and examining results. No source of Electricity occurred in the toll house. But I must consider further whether any source could exist in the river independent of magneto-electric induction.

JANY. 13, 1832.

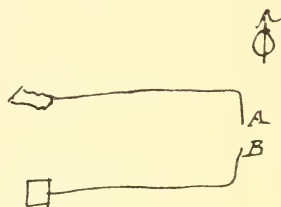
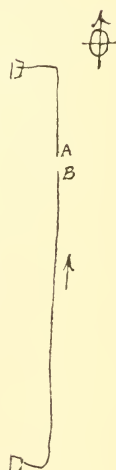
311. Experimented again at the river between 11 and 1 o'clk at Waterloo bridge. Tide running down fast, i.e. from West to East. Used plates of platina about 10 inches square (one was the other) instead of copper plates: copper wires were soldered to them as before and the plates were clean and brush[ed] and ignited before being taken from home—quite metallic.

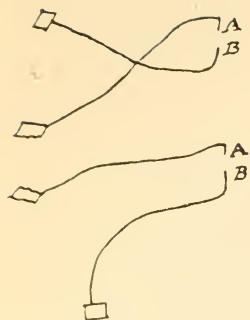
312. The horizontal wire was now stretched from the second pier to the seventh and extended over the five middle arches; its length was about 700 feet long and there were two arches at each end between the platina plates and the banks of the river. The platina plates being connected as before were lowered, and kept under water by iron weight attached to them at a distance by string.

313. When contact was made there was plenty of electricity like last night. When connected as in the figure the marked pole of needle went east and was held there. Two or three making and breakings of contact swung it round. On making contact therefore current of electricity was in wire as marked, and therefore from north to south through the water, but as latter moved from west to east I expected the opposite current.

314. Then went along the wires to see they did not touch the iron gas pipes anywhere. In contact with the Granite only all the way. Took off the iron weights and let the platina float on the surface of the stream. Still the effect was as great as before and the direction the same.

315. Took up the plate and wire at the south end of the line. It was the square soldered plate. The other plate at the north end was the irregular jagged new plate. Brought the former or square plate to the same pier as the other and put them both in the water near together. On *making* contact there was a deflection, weaker than the former, but yet marked pole of needle went *east* as before.





316. Then let one drift under the Arch, the other being held near the pier; and afterward took the first near the pier and the other allowed to float under the arch. Still on making contact as marked the marked pole of the needle always went east—as if each plate had a permanent power of sending electricity in a determinate direction independent of its position in the water to the north or south.

317. Both plates were I think somewhat tarnished and on that to the south, i.e. the soldered old plate, was a red tinge looking like copper. This is to be examined; and also effect of temperature of water. The Thames water was turbid and dull. Rainy weather lately.

JANY. 16TH, 1832.

318. Examined the two platina plates used. The red tinge is from oxide of iron which it acquired in one of the furnace expts. on glass.

319. On putting the two plates in pail of water galvanometer was deflected, a current of Electricity passing from ragged plate through the galvanometer to the square patched plate.

320. Cleaned both plates much with sand paper—first burnishing out all inequalities—removed all redness.

321. On now immersing the plates found contrary deflection and that very strong. After a time found these irregularities were due to the solder used to attach the copper wire. Now immersed the plates in part only, keeping the solder and the copper out of water. Now no sensible action.

322. Poured hot water in about and behind one plate: produced a little effect, but found it was not thermo electric, for on making the other plate and all the water equally warm it continued. It was due to some slight difference between the plates which was exalted in the well known manner occasioned by heat.

323. Now took solution of pearlash in a large tub—rotated it fast and held in platina plates (the solder and copper having been covered with wax and also kept out of the fluid); obtained no deflection, and believe that in this way (with every proper precaution, it is not sensible.

324. When a little piece of copper was put in contact with one

of the platina plates it immediately altered its relation to the other, and a current pass[ed] through the galvanometer.

325. The copper plates put in the alkaline solution gave a current: they were too unlike, i.e. they differed in a little oxide or some other point.

326*. Now experimented on direction of current induced when a magnet is introduced into a hollow helix, for from theory if it were carried quite through it should produce two deflections, one one way one the other, inasmuch as two poles of contrary nature are carried past the wire: found this to be the case.

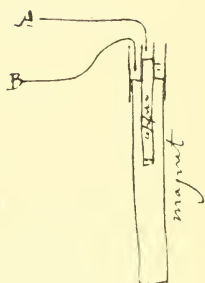
327. When the magnet was introduced a deflection took place as before described. Being in, whether it were pushed in the same direction quite through, or withdrawn, a deflection the *reverse* of that just mentioned is produced.

328. When carried in and through at one motion the needle moves one way, is then suddenly stopped, and then moves the other way; just as with the helix carried between poles and for nearly a similar reason.

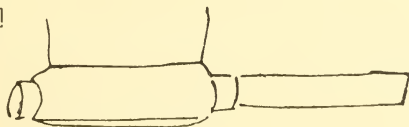
329. If therefore a hollow helix be laid East and West, and a magnet be retained East and west, its marked pole always being one way, then which ever end of the helix the magnet goes in at and consequently whichever pole of the magnet enters first, still the needle is deflected the same way: and on the other hand, which [ever] direction is taken in withdrawing the magnet, still the deflection is the same, being the contrary direction to the deflection due to entrance.

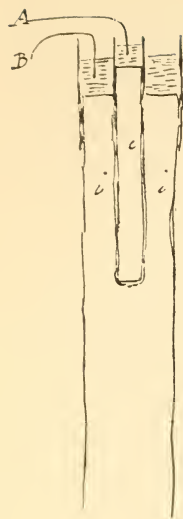
330. All these effects are consistent with and were theoretically deduced from the law described.

331. Now experimented with a cylindrical magnet having a hole one third of its diameter in width made at one end in the line of its axis and penetrating perhaps 3 inches. Into this was fitted a copper cylinder surrounded with paper and amalgamated at its upper and lower end. When in its place it formed metallic contact with the middle of the magnet by a little mercury; was insulated at the sides by the paper, and rose about $\frac{1}{2}$ of an inch above the end of the magnet. A quill was put over it down to the paper and formed a little cup to receive mercury to complete contact. Then



* [326]





a high paper edge was raised round that end of the magnet and mercury put within it; but this had no connection with the mercury in the quill, being quite insulated from it.

332. When therefore wires A and B were dipped in these two portions of mercury, any current of Electricity through them must pass down the magnet towards its equatorial parts and then up the copper rod, or vice versa. The intention was to see whether, when the magnet was rotated, the parts at *i*, *i*, etc. could produce currents which the copper rod *c* could discharge down the axis, it having the same angular velocity with the other parts. It was expected not.

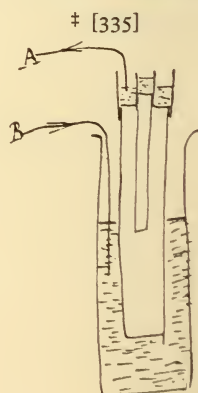
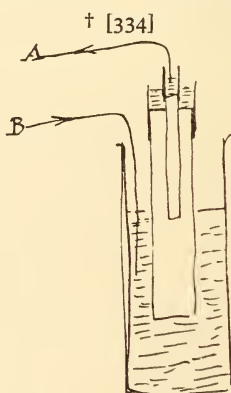
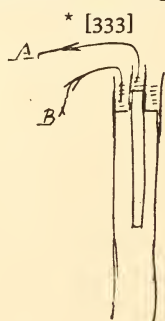
333*. When thus arranged and rotated screw fashion the marked end of the galvanometer needle went *west*, and there was therefore a current through it from A to B. But it was very feeble indeed and could hardly be observed. The marked pole was upwards in all these expts.

334†. Then put the magnet in a jar of mercury and put wire B in metal in the jar, so as to be in contact with the equatorial part of the magnet instead of its polar extremity. Revolved screw or clock fashion as before and marked pole of needle went *west* as before: but now far stronger than before, though evident that parts of magnet from equator to pole out of the electric current.

335‡. Then put wire A in mercury on end of magnet and left copper axis out of view altogether. Rotated Screw or clock fashion and so got again deflection of marked end of the needle to the *west*, and current as strong as the last time and very much stronger than the first.

336. Hence it is evident that there is no discharge in the middle of the magnet, for the current now freely evolved is up through the magnet, but in the first experiment it was down. In fact in the first expt. it is only the part equal to a little disc extending from the end of the wire B in the mercury to the wire A that was efficient, i.e. moving with a different angular velocity to the rest, and for that little disc the direction of the current is right.

337. But in the other two it is not only the action of that supposed little disc, but of the lateral parts of the magnet which move relative to the galvanometer wires at rest, and hence the great



action obtained. For the discal part the direction of the induced electric current is the same in all three experiments.

JANY. 17TH, 1832.

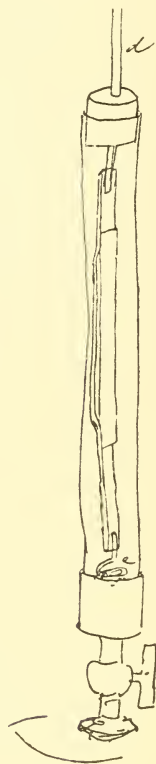
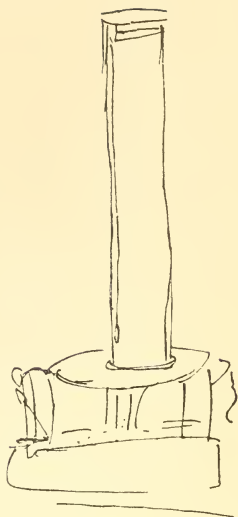
338. Attached a little disc of thin copper foil $\frac{1}{2}$ inches square to a very thin film of spun glass; fastened the other end of the film to the cap of a guinea and feather fall so that little disc hung near the side of jar and face towards it. The glass thread was nearly two feet long and allowed the disc to move with very little impulse. Then the jar was put on an air pump and exhausted until mercury stood at about 29 inches. Now brought the pole of large bar magnet towards jar, opposite the disc; looked for repulsion of disc as pole approached and attraction as pole receded. Reiterated these actions in accordance with the times required for vibration of the disc within as a pendulum, and thought I got effect.

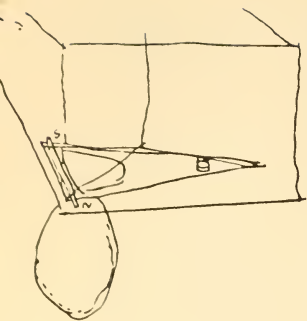
339. Now removed the air pump to a stone floor and repeated the experiment, and at first thought I got distinct effect; but by chequing the experiment found it depended upon the foot touching one of the flag stones touched also by the air pump.

340. Now fixed the pump on separate basis and first ascertained that all the bodily motions required in approaching the magnet caused no vibration. Then found that the magnet caused none either, although the two similar poles of the two bar magnets were put together. No effect at all from Magnet.

341*. Now arranged an apparatus consisting of a thin plate of copper bent in the middle part thus—and amalgamated at *a* and *b*, and then a strip of leaf gold stretched across loosely so as to be in metallic contact at *a* and *b*, but free to move at *c*. This was soldered at one end to a thick copper wire *d* and at the other to a spiral of copper, amalgamated, *e*. The copper *d* was passed through a cork made tight in the end of a tube of glass: the spiral *e* pressed into mercury at the bottom of the cap at the other end of the tube. Then the tube was exhausted of air and magnetic poles passed by the gold leaf, etc.; *d* and the stop cock being sometimes connected by a copper wire to complete the circuit and at other times not. Not the slightest evidence of action appeared under any circumstances although the Magnets were tried in all ways and the gold leaf moved very freely.

* [341]





342. Tried Arago's effect of repulsion. Put a long magnet on a pastboard plane hung at three corners from silk fibre and balanced so as to move in a horizontal plane. The magnet brought it to a state of rest. All enclosed in glass frame and on a separate table. Then revolved copper plate near to marked magnetic pole outside of the frame, the plane of the plate being parallel to the plane passing through the pole and the line of suspension. Hence motion of pole directly to or from the plate. Could get no effect either way, but when the plate inclined a little to the aforesaid plane, then got motion of the needle to or from in accordance with its power of passing with the plate one way or the other. Hence do not here find verification of Arago's effect.

343. Tried a magnet on both sides of Arago's plate. If Herschell and Babbage were right, a pole of the same kind on each side of plate should do more than a pole on one side, or than opposite poles on opposite sides. If I am right the reverse should be the case. Used Sturgeon's [Arago's] plate: arranged it nicely. It made a certain no. of vibrations before the Arc fell from one quantity to another.

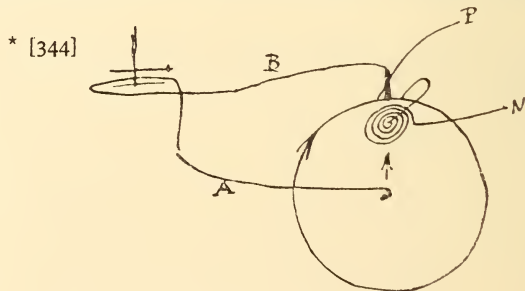
Alone it made of vibrations 62, 56, 60, 61

Different poles	„	„	21 20, ... 15	} * equally near.
Similar poles	„	„	58 58, ... 50	

On putting two pieces of wood as near as in the last expt.* the no. of vibrations was diminished to 52. Shewing that the difference between 50 and 60 was due more to obstruction of air than residue of magnetic action. Very Good Expts.

FEBY. 23RD, 1832.

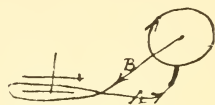
344*. Two double spirals each containing about 18 feet of wire were arranged parallel to each other, about half an inch apart, and connected with each other and with a voltaic battery so that the current passed in the same direction through both. The large copper plate was then arranged in the plane of Mag. meridian with its edge interposed between the spirals. The wire B of the galvanometer was brought by a leaden collector in contact with the edge, and the other wire A by another collector in contact with the axis of the plate. On revolving the plate the galvanometer



was deflected. As the plate revolved clock fashion the marked pole of the upper needle went East. As the plate revolved against clock or unscrew the marked pole went west.

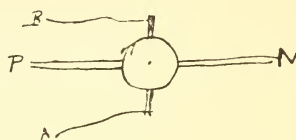
These spirals were of Iron wire.

345. Now used one double spiral of copper wire containing feet of wire. It was arranged horizontally thus, and then a small copper plate about $1\frac{1}{2}$ inches in diameter arranged over it but with paper between. When this plate was rotated, the galvanometer wires being connected with the edge and axis as figured, the needle was deflected. When the plate revolved clock fashion the marked end of needle went east. When it revolved against clock the marked end went west.



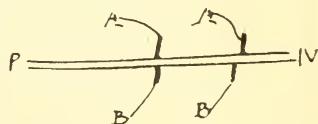
346. Thus mere Electro-magnetic spirals act as magnets and the directions of the induced currents, etc. are the same.

347. Then arranged the small disc of the last experiment above a single strait wire carrying the current of the battery (100 pr. of plates, but charge old) and revolved it with wires of galvanometer applied at each side of disc, thus. There should be an induced current right across the disc perpendicular to the wire PN.



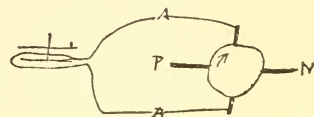
348. With a wire as thick as a quill obtained no effects, but with a wire about $\frac{1}{20}$ of an inch in diameter obtained slight vibrations at the galvanometer, which I believe to be from true induction excited by a single wire.

349. Stretched a straight wire, amalgamated on surface, through which the current of the battery was sent. Brought wires from the galvanometer in contact with it at opposite sides. There was no action, but if the wires A and B were removed from each other on the main wire only the $\frac{1}{8}$ of an inch a current took place through them and the galvanometer. If removed an inch apart it was greater. If removed 10 or 12 inches apart the galvanometer needle was flung round.



350. The experiment is very beautiful and in some researches very useful. But it does not relate to my present research except as the effect prevents me from moving the wires A and B along the principal current wire to get an effect of wire motion.

351. The $1\frac{1}{2}$ inch copper disc was arranged with four leaden bearers against it. Two of these, P and N, were used to transmit the current of the battery through the disc, being retained in con-



trol by springs; the other two were connected with the wires A and B of the galvanometer. On revolving the disc whilst the main current went through it I could find no evidence of a cross current by induction.

352. I then used a little disc only $\frac{1}{2}$ inch in diameter and about $\frac{1}{5}$ of inch thick in the same way. There was here feeble traces of motion at galvanometer, but I incline to think they were due to the rotation of the disc carrying the wires A and B a little sideways (to the principle current), first one way and then the other as the rotation was changed, and thus producing an effect like that described in the last page.¹

353. Still I see no reason why a revolving disc should not thus produce an induced and cross current if the adjustments are good and the principle current strong.

354. Try single Voltaic arrangements.

FEB. 27, 1832.

355. Made the expt. 345 with the same disc and spiral, but used only a single pair of plates (double copper, the zinc about 10 inches square and arranged in a circle). The action of the acid was weak and tranquil, yet the electrical result of the experiment was much stronger than in the former case.

356. The current from a single pair abundantly sufficient probably for all these experiments.

357. Adapted conductors to the large copper plate so as to make better contact, taking 4 inches of the edge and more of the axis. Then rotated plate perpendicular to the dip and connected conductors with Galvanometer, but only by small wires (had not large ones). Effects not greater than in former cases.

358. Arranged the plate horizontally—put marked pole of large bar magnet beneath it, revolved the plate and obtained plenty of electricity. Then put unmarked pole of other similar magnet above over place of lower pole, revolved, got much more electricity. Then put marked pole of upper magnet over plate so that there was a marked pole on each side. Got very little electricity on revolving plate. Adjusted the magnets, one nearer to, the other farther from the plates, and at last found a position in which plate

¹ i.e. at par. 349.



when revolved gave *no electricity*. After that found that the pole which required to be brought nearest to neutralize the other was the weakest. This is a beautiful experiment and shews the destruction of the electric current by similar poles on opposite sides. If now the action on plate disappears at same time this will prove that Babbage and Herschell notion is wrong, mine right, for on their view effect ought to be *increased*.

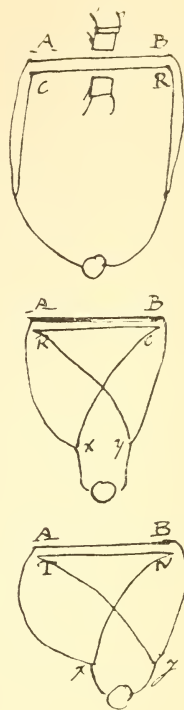
359. Now tried to oppose action of different metals to each other so as to get a difference thus; passing two pieces of metal between poles of strong magnet, having the ends of the pieces of metal connected with the galvanometer but in contrary directions, it was thought that the difference might be found. Thus AB was one copper rod and CR another. When separated by paper and then passed between poles the needle was affected. But on reversing CR as in the figure, all the connecting wires being copper and of equal lengths and quality from the ends to x, y , then no deflection took place. The action of the two being supposed to neutralize each other. When AB was a thick copper wire and CR a thin one, still they neutralized each other. Then used Tin instead of CR, but now found no deflection, so that expected result not obtained.

360. Suspected that the current in AB was so freely discharged through $xNTy$ that even if latter not passed between poles it would carry off most of the electricity from AB, and it was so, for on putting TN still in metallic connexion on one side and passing AB only by poles, there was a little and but little effect on the needle. When TN therefore causing current in reverse direction there was no power left to deflect the needle.

361. Must use a galvanometer with two wires only, one for the copper and one for the tin, acting on the same needle.

362. Now have had a plate of soft Iron made like the vibrating plate of 343, for if I am right, nothing is more different than ordinary magnetic induction on iron and the magnetic effect of the current produced as I find them. The plate vibrates just as the former and very nicely.

363. This plate vibrated until the extent of the vibration was diminished from one arc to a smaller, both marked on the plate and indicated by an index point from the stand itself.



Alone the plate made 33, 32, 32 vibrations.

With one pole of bar Magnets end on,

$\frac{1}{2}$ inch from edge, only 5 vibrations

" " 1.1 inch from edge, about 11 "

With marked pole at one side of edge 3.75 vibrations

" " a little further off 5 vibrations

With marked pole of second bar on opposite side of plate, same distance 2 "

With unmarked pole of second bar on opposite side

do. do. 22 "

By removing the stronger of these two opposite poles a little away from the plate increased vibrations to 31. By removing it altogether reduced them to 5 or 6.

364. Nothing more clear than that with iron *Opposite poles* on *opposite sides* of the edge of the plate *neutralize* each other, and that *similar poles exalt the action*. *A single pole end on is also sufficient*.

365. Now with a copper plate (345). *Similar poles* on *opposite sides* of the plate *neutralize* each other. *Opposite poles exalt the action* and *a pole at the edge or end on DOES NOTHING*.

366. A magnet edge on to the plate ought not to rotate with it.

367. The expts. with the Iron plate abundantly shew the point of time required in *ordinary magnetism*, and Herschell and Babbage are right in that respect.

FEBY. 29, 1832.

368. Have constructed a double galvanometer, i.e. two separate coils and a double needle between; is very delicate and good.

369. On connecting a copper bar with one coil and a second copper bar with the other coil, separating the bars by paper and passing both between the poles of Mr Daniell's magnet at once, the effect on the galvanometer was strong, the bars both being in the same relative needle. But on reversing one bar and then putting them together and carrying them through, the needle did not move even after many reiterated passages of the bars by the poles. In fact the effect of one was exactly equal to and therefore neutralized the effect of the other.

370. Then replaced one of the copper bars by an iron bar and passed the two, i.e. copper and iron, through between the poles, they being in opposition relations to each other—still no action. Used copper and tin; still no action. Hence would seem as if copper, iron and tin were equal to each other.

371. But in these cases all the rest of the communications were copper and equal, good in all, and as the effect depends upon the whole circuit, this may influence results. In the revolving wheel the whole circuit performed by the current is always in the same metal, i.e. all copper or iron or tin or zinc, etc. etc.

372. Took therefore a long copper wire reaching from the galvanometer to the magnet and back and connected it with one galvanometer, and also an equally long iron wire and connected it with the other galvanometer, so that each coil circuit was completed in one case by iron in the other by copper. Then brought the parts near the magnet together, interposing paper and placing them so as to act in opposite directions; and so passed them between the poles of the magnet. Now the galvanometer needle was affected, and in accordance with the copper, shewing that the copper had a greater power than the iron.

As there were about 11 or 12 feet of copper and iron compared, whilst all the wire in the galvanometer coils (in each about 18 feet) was copper, it is clear only half the two-fifths of the superiority of copper over iron or thereabouts would be shewn.

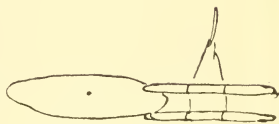
373. Believe that the metals act according to their conducting powers simply.

MARCH 1, 1832.

374. Arranged revolving plate—one magnet end on so that the pole was opposite the edge. No revolution or action. No rotation of the pole with the plate.

375. Same pole put below the edge and opposite the side of the plate. Then it revolved with the plate.

376. Letting that remain, a similar pole was put in a corresponding position above the plate: the action of the first was immediately neutralized and the poles did not travel with plate. The plate was of course enclosed in a sheath of paper to prevent wind from it affecting the magnet.



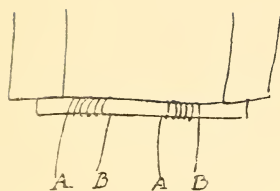
377. Opposite poles on opposite sides of the copper plate were best of all. The very excellent proof of truth of theory.

378. Connected the iron ring and its helices, using a single pair of plates. Could get no spark at the other helix. But the effect on the galvanometer on making and breaking contact was very powerful.

379. Had a series of wires of copper, platina, iron, zinc, silver, lead and tin drawn to the same size—connected them end to end and then with a battery, a single pair of plates, so that the current passed through all. Then brought the wires in succession into exactly the same position and distance from a delicate glass thread torsion galvanometer—but they *all* deflected the needle alike. No difference therefore for different metals when equal currents passing through them.

Pursued expts. 371, etc. of Feb. 29th.

380. Have had wires $\frac{1}{20}$ of an inch in diameter drawn of Zinc, iron, copper, tin and Lead, and now tried them by the double galvanometer 368, etc. In the following manner. A round soft iron bar $\frac{3}{4}$ of inch in diameter was taken, long enough to connect the poles of Daniell's magnet; 16 feet of each of the five wires was cut off. The ends of the copper wire were connected with A and B of galvanometer coil 1 and the ends of the Zinc wire connected with A and B of galvanometer coil 2. The middle part of each wire then made six convolutions round the soft iron bar (covered with paper at the parts) in two places forming 2 helices, the convolutions being separated by string. The two helices formed were in opposite directions so as to send opposing currents through the two galvanometer coils, leaving the needle to be affected by the excess of the most powerful.



381. On making and breaking contact the needle was affected as it would have been by the copper wire alone, but less powerfully. As it was possible the two galvanometer coils might differ a little in their force upon the needle, either by the vicinity of the needle or otherways, the copper ends were changed for the zinc end[s] and the zinc for the copper, so that each metal in turn acted on each galvanometer coil, but still the Copper beat the zinc.

382. All these metals were then tried, two and two. Copper overpowered the rest. Then Zinc overpowered Iron, lead and tin,

and was therefore second. Iron overpowered lead and Tin and was therefore third. Tin overpowered lead and lead gave way to all. Hence the order is

Copper
Zinc
Iron
Tin
Lead

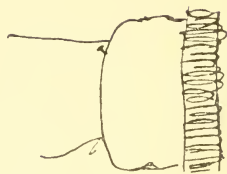
and it is exactly the order of the conducting power and with the exception of Iron the order in the Magneto-rotation experiments. Hence all is in agreement; but Iron can be interpolated, whereas in the other way, by rotation, its place is uncertain because of ordinary magnetic effects.

MARCH 5, 1832.

383. Experimented with the helice B (20) which contains 6 iron helices amounting together to 214 feet and six copper helices amounting to 208 feet. The iron extremities were connected together *side by side* and the copper extremities also, so as to have four general terminations, two of the iron, two of the copper. The ends of the general copper helix were made fast to coil 1 of the new galvanometer and the ends of the iron helix in the contrary direction to coil 2. Then passing in one of my cylindrical magnets the galvanometer was well deflected. On trying the deflection of the iron or copper helix alone, the first was in the contrary direction and the second the same but stronger than the one produced above. Hence Copper had overpowered Iron as before. The effect was very striking.

384. Connected the similar ends of the copper and iron helix together at one side and the other ends with the galvanometer arranged as a single instrument: passed in the magnet. No effect. This experiment is the same as 283, etc. and the result the same. It proves with the rest the sole dependance upon conducting power and the compensation (exact) when two different metals are used.

385. Connected Copper helix ends by a wire thus. Then made ends of long galvanometer wire fast at *a* and *b*; passed in the



magnet and still found the galvanometer was affected, though from *a* to *b* was not more than 2 feet direct and through the galvanometer was between 50 and 60 feet. Shews division of current and great care required in experiments.

MARCH 8TH, 1832.

386. Experimented again as to taste, chemical decomposition, Spark and frog, etc. etc. etc.

387. Used first the new wheel between poles of Daniell's magnet, connectors applied at axis and edge as usual—the connectors attached to platina plates and paper soaked in Sul. Copper put between them. Could get no decomposition though we turned for 5 minutes in one direction.

388. Put frog prepared between similar platina plates and turned wheel but could get no agitation.

389. Then took away wheel and used hollow copper helix; connected the ends with the platina plates and put one above and the other under the frog's limbs. Put an iron rod into the helix and connected it with the poles of magnet; immediately convulsion of the frog.

390. If the soft iron were taken slowly to the poles, there was no convulsion of the frog, but always if taken up rapidly. Again at first could not find the convulsion on breaking contact, but on making the rupture rapidly by knocking off the connecting iron then got the convulsion strongly. Happened only at making or breaking contact.

391. Thought I could also get a taste and a flash but was not sure.

392. Could not get a spark either by charcoal or without.

393. Time of travelling of Magnetic impulse.

394. „ „ impulse of Electric induction.

395. Query application of theory of vibrations.

396. When the travelling wire moves only through magnetic curves of equal intensity—can the effect of induced current be due to any thing else than relief on one side of wire relative to its position to the curves and tension on the other, i.e. to time required in propagation?—for the motion requires time and implies occupation of time in the powers producing the tension (tangential powers?).

397. References to new point of investigation, time, vibration, etc. etc. also interception, reflexion, etc. 51, 74, 244, 291, 342, 367, 393, 394, 395, 396. See also list of Expts. 21, 22, 23, 74, 79, 84, 90, 210, 219, 220, 221. Also p. xvii.

MARCH 26TH.

398. Conceived that as electricity in passing made magnetism at right angles, so if electricity still and needle moved in opposite directions, should become a magnet, for then the electricity and metal are relatively moving and that seems the only condition required.

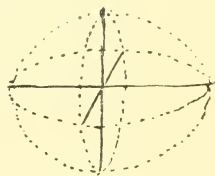
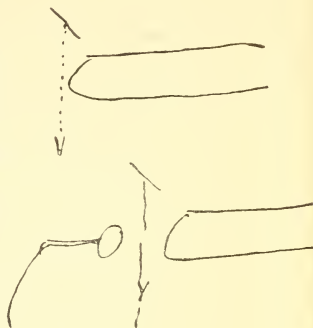
399. Made a very delicate mag. needle, very feeble. Took other minute needles and passed them near to end of conductor, the needle and its path of motion being perpendicular to each other. The conductor belonged to a small electrical machine and was charged. Could not in this way get a magnet.

400. Then held knob near conductor and passed the needle between the two, but could not get signs of magnetism in it.

401. When sparks were passed from the conductor to the ball, the needle being near, they did not make it sensibly a magnet, so that evidently could not expect effects from the mere motion of the needle.

402. The lines or directions of force between 2 electrical conductors oppositely electrified may be called *electric curves* in analogy to *magnetic curves*. Do they not exist also in the electric current wire?

403. The mutual relation of electricity, magnetism and motion may be represented by three lines at right angles to each other, any one of which may represent any one of these points and the other two lines the other points. Then if electricity be determined in one line and motion in another, magnetism will be developed in the third; or if electricity be determined in one line and magnetism in another, motion will occur in the third. Or if magnetism be determined first then motion will produce electricity or electricity motion. Or if motion be the first point determined, Magnetism will evolve electricity or electricity magnetism.



404. Harris' expts. on interposition of copper, silver, etc. between moving magnet and iron plate prove absorption of power of magnet by the interposed metals and consequently a *reaction*.

405. Will these metals *obstruct* equally the force of a magnet at *rest*?

406. Will flame intervening obstruct power of moving magnets but not of magnets at rest?

407. Will white hot iron allow magnetic forces freely to pervade it, i.e. when not magnetic is it no obstacle?

APRIL 6TH, 1832.

408. Had two brass plates, each 3 inches by 6 and flat, each with a wire P and N fastened to it. Obtained two glass plates 6 inches by 9 inches, thin and flat; held all together as in the figure, when they formed a Leyden arrangement of some force. Opened the edges of the glass plates a little, still the Leyden arrangement was strong.

409. Now immersed the whole in Oil (lamp), connected P with the prime conductor of machine and N with the ground. Took a small needle free from magnetism and by a whalebone slip drew it up from *a* to *b*, then discharged the arrangement, depressed the needle, recharged the arrangement and *raised* the needle. Repeated this again and again many times, endeavouring to cut the electric lines of tendency or curves by the needle and make the latter a magnet; but could get no traces of such an effect.

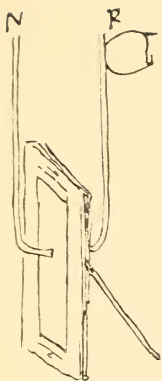
410. The Leyden power of the arrangement *in the oil* was much weaker than in the air. Cleaned every thing therefore and repeated the experiment in the air, but could get no magnetic effects.

APRIL 7TH.

411. Repeated the experiments in air but could get no magnetic effects.

APRIL 17TH.

412. Have experimented upon screening power of copper when at rest or in motion. In latter case ought to screen. Used the two bar magnets, put similar poles together—they were arranged horizontally and in magnetic meridian, the marked poles southwards. Used a double needle (belonging to the galvanometer) vibrating



slowly, i.e. to and fro in about 20". It was put magnetically south of the bar magnets, at the same elevation and about 3 feet off, and was deflected about 70° from its natural position, the stronger marked pole which gave direction to the whole going westward.

413. Now arranged the copper round plate on whirling table in a vertical plane perpendicular to Mag. meridian and close to the marked magnetic poles of bars, so as to form a screen between them and the distant needle.

414. When the plate was interposed and then removed isochronously with the time which would be required for the vibration of the needle, still not the slightest effect was observed; whether there or not the magnetic influence between the bars and the needle was equally strong.

415. But when the plate instead of being removed was made to revolve then the magnetic forces *were affected*. Upon revolving the plate 10 seconds and then leaving it still 10 seconds and so on several times, the vibrations of the needle were varied to several degrees.

416. When the plate revolved the needle tended to return to the position it would take if no bar magnets had been used, i.e. the power of the latter over it was diminished.

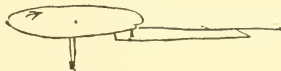
417. Whichever way the plate revolved the effect was the same, i.e. as if bars had been removed a little further off.

418. Hence moving metals screen magnetic power off when still metals do not, i.e. the currents of electricity generated by the vicinity of the mag. pole react upon it and neutralize part of its magnetism. As it ought to do and as was expected.

419. Hence Harris' expts. in screening influence involve a fallacy, for his magnet was moving and currents were formed.

420*. At first the apparatus was arranged with the parts at different altitudes, but then the needle was affected by the *current* produced, and went this way or that as the motion was one way or the other. In the arrangement already described the magnet was so place[d] that the principal current was horizontal and therefore tended to raise or depress the needle but not to make it approach to or recede from the plate; and then it was found that revolution *either* way always made the needle approach the magnets and *rest* made it recede.

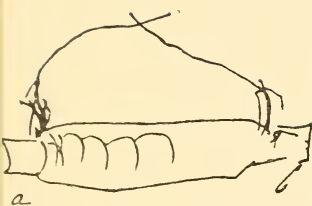
* [420]



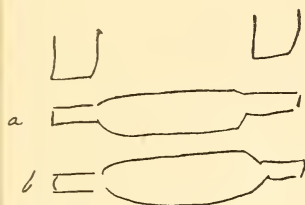
421. The bar magnets and needle being as first arranged (412, etc.), a bat's wing gas burner was so arranged as the flame should occupy the place of the copper plate, acting as a screen and cutting the magnetic curves proceeding to the needle. It was then turned on and off alternately at intervals of 10 seconds so as to indicate any effect it might have over the curves. It being supposed possible that the heat might do something, but no results were obtained, i.e. the magnetic forces did not appear to be at all diminished when intersected by the flame.

422. It is very necessary in these expts. to take care and avoid the motion of portions of iron about the burners or vessels during the expts. Effects were at first obtained which after a while were found referable to these causes.

1832. FEB. 8TH.



423. This Evening at Woolwich experimented with Magnet and for first time got the Mag. spark myself. Connected ends of a helix into two general ends and then crossed the wires in such a way that a blow at *a b* would open them a little. Then bringing *a b* against the poles of the magnet the ends were disjoined and bright sparks resulted.



424. They were produced as the lifter went up and also as it was pulled away.

425. In pulling away, 3 or 4 sparks in succession could be observed, i.e. as lifter went from poles to *a* a spark, and also as it went from *a* to *b* a spark, i.e. without even touching the magnet.

Proposed using hydrogen but had not any at hand to inflame.

FEB. 9TH.

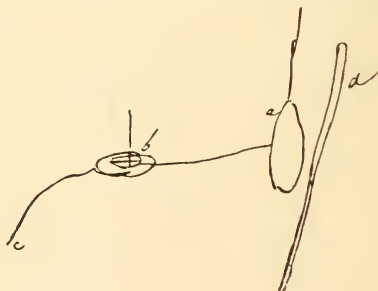
426. At home succeeded beautifully with Mr Daniell's Magnet. Amalgamation of wires very needful.

427. This is a natural loadstone and perhaps the first used for the spark.

FEB. 16TH.

428*. *a* a brass plate hung by silk, connected by wire with galvanometer *b* and that with wire *c* passing off to the earth. An excited Glass rod *d* brought towards and from *a* alternately—there

* [428]



should be current through wire of *b* but could not get any effect. Try however expt. in better and larger way.

1832. JUNE 11TH.

429. Have been experimenting on chemical power of magneto-electric current, etc. etc.

430. On tinning the surface of the copper plate and the end of the wire resting on it, obtained (after amalgamation) a much better spark than before. Very good, but amalgam of tin may perhaps wear off.

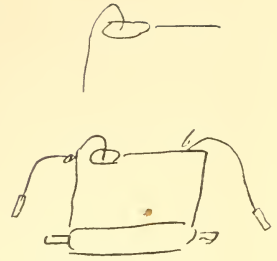
431. On making two copper wires attached to platina spatulas fast at *a* and *b* so that the tongue could be put between the spatulas and yet the contact of the end on the plate allowed to be broken as in former cases, a very powerful effect on the tongue was felt each time the contact of the lifter with Daniell's magnet was made.

432. On putting one of the spatulas up the gums the flash was very strong.

433. Then mixed a little solution of starch with solution of hydriodate of potassa—dipped bibulous paper in it and put it between the two spatulas so that they did not touch, but the current passed the solution. As the lifter with its helix was raised from the Mag. poles, allowed the plate and point to open, that the current might then be diverted and pass through the solution. As the lifter was put down on the poles, kept the plate and point close so that no current should pass solution. All that did pass wire therefore one way. Repeated the action many times so as to accumulate chemical effect. The spark was evidently smaller at the plate and point shewing that electricity went through the solution, but not the slightest appearance of decomposition occurred—no blueing of the starch.

434. Now put up the revolving plate between the poles of Daniell's magnet and could obtain with it a permanent deflection of the magnetic needle of 45° or 50° or more.

435. Then attached to the ends of the wires used a piece of platina and a piece of zinc wire; put the end of the platina wire into a glass of very dilute acid and then immersed the zinc wire so far as to give about 40° of deflection to the magnetic needle; for this about $1\frac{1}{2}$ inches of the zinc wire were required to be



immersed. This therefore formed a voltaic comparative arrangement.

436. Interposed elsewhere in the circuit the two platina spatulas separated by paper moistened with the starchy hydriodate of potassa. Using the standard voltaic arrangement just mentioned the needle was now very feebly deflected, instead of 40° or more now hardly 10° ; but after a little continuance, on examining the moistened paper decomposition had proceeded and the starch had been rendered blue. It required more than a momentary duration for this purpose. After a few seconds no change was visible. In half a minute it was sensible, in a minute or two very strong.

437. Hence the original current, though much impeded, could pass the interposed solution, and if time were allowed sensibly decompose it.

438. Now using the current from the wheel and magnet, when this was interrupted by the platina spatulas and interposed moistened paper, etc., *No* deflection of the needle could be observed, nor after several minutes turning could any signs of decomposition be discovered. This current therefore, which when all in metal could deflect the needle more than the other, had no *sensible* power under these circumstances of passing fluid conductors. No doubt it would pass if exalted enough and then most probably decompose. Hence the hydro current more intense.

439. The little voltaic arrangement (435) did not affect the tongue so strongly as the first arrangement with the magnet (431); but then it was constant.

440. So that the effect of the Magnetic helix was strong enough but not long enough, and the effect of the wheel was long enough but not strong enough.

441. Then by means of little voltaic arrangement (435) tried the delicacy of different tests of voltaic action. Solutions of Acetate of copper, Mur. Gold, Acetate of Lead and sub acetate of lead, put in drops on one platina spatula and touched by the other so that the current of the Voltaic arrangement passed through them and feebly affected the needle, still did not give sensible signs of decomposition in a few minutes. But the mixed solution of starch and hydriodate of potassa did give very abundant proofs in same time. Hence the latter a very delicate test. The best of these.

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